US Army Corps
of Engineers
Kansas City District

Engineering and Construction Division
Hydrologic Engineering Branch
Water Management Section

# Annual Report of Reservoir Regulation Activities

## Summary for 2000 - 2001

January 2002

**NORTHWESTERN DIVISION, KANSAS CITY DISTRICT**
**SUMMARY OF LAKE REGULATION ACTIVITIES**
**AUGUST 1, 2000 TO JULY 31, 2001**

## PURPOSE AND SCOPE.

This report summarizes the past year's regulation activities at lake and reservoir storage projects within the boundaries of the Kansas City District (District) that are operated for flood control by the Water Management Section staff. It also summarizes major work items affecting the projects, and it outlines briefly the programs ongoing or proposed for the year ahead. Topics discussed in the report include climatology, project accomplishments, current project operations; major regulation problems and proposed solutions; lake regulation manuals; data collection programs and procedures; ongoing studies, and personnel of the Water Management Section. The reporting period for Water Management Section activities primarily covers the operating year from August 1, 2000 through July 31, 2001, with additional discussion on proposed operations and studies programmed through calendar year 2002. The reporting period for certain items reported by other District elements may cover the fiscal year or calendar year, depending on the reporting requirements specified by their applicable regulations. Preparation of this report is in conformance with paragraph 13b of ER 1110-2-240, dated October 8, 1982.

## LAKES IN THE KANSAS CITY DISTRICT.

The Kansas City District encompasses the watershed of the Missouri River from Rulo, Nebraska, (mile 498.1 above the mouth) to the junction of the Missouri and Mississippi Rivers near St. Louis, Missouri. During the period covered by this report, 29 storage projects at which the Corps of Engineers (Corps) has either complete or partial water control responsibilities were in operation within the District. The location of each lake and reservoir in the District is shown on Plate 1, and a summary of engineering data outlining the physical characteristics of each project is included as Plates 2A through 2E.

## PROJECT FUNCTIONS AND GENERAL PLAN.

Functions served by storage facilities in the Kansas City District include: flood control, irrigation, water supply, low flow and navigation supplementation, water quality, hydroelectric power, recreation, and fish and wildlife. All functions but flood control are normally provided through the regulation of storage contained in the multipurpose pool. Hydropower is generated during releases from both flood control and multipurpose storage. The general plan for regulation of flood control storage is to evacuate all accumulations in the flood control space as rapidly as downstream channel capacities and flow conditions permit. Should the top of the flood pool be exceeded, criteria have been developed for each project that schedule releases with an aim toward safeguarding the structure. Downstream interests are warned of the possibility of flooding should a surcharge operation appear likely. Releases from multipurpose and flood control storage are regulated mainly by the manipulation of gates or other means in accordance with plans, schedules, and rule curves prepared in advance to meet various conditions of inflow, water demand, and downstream channel conditions. Releases from surcharge storage at most of the projects are through uncontrolled spillways, although a few of the larger projects have tainter gates installed in the spillways. Although the storage space in the flood control pool is normally evacuated as quickly as downstream conditions allow, release schedules may be modified at times to serve other uses such as fish and wildlife enhancement and navigation flow supplementation when stored water occupies only the lower portion of the flood control pool.

## CLIMATOLOGY AND HYDROLOGIC CONDITIONS.

The year 2000 began with relatively warm and dry conditions, extending drought conditions that became established in the second half of 1999. At the beginning of the year most of the Kansas City District was classified as being in a moderate drought by the National Weather Service (NWS) Climate Prediction Center Drought Monitor. Much of the District received normal precipitation in the early spring, with the wettest conditions to the south. But a dry weather pattern became reestablished in April and May, intensifying the drought conditions in parts of Kansas and Nebraska. Central and eastern portions of the District benefited from rains in June and July, reducing drought conditions in those areas. During that period, scattered minor to moderate flooding occurred on Missouri streams and along the Republican and Blue Rivers in Kansas. Inflows to Federal lake projects in the District for the operating year ending July 2000 were only 41 percent of normal, among the lowest on record. Fiscal year (FY) 2000 hydropower production at Harry S. Truman Reservoir and Stockton Lake in Missouri was less than 20 percent of normal.

August to mid-September was hot over most of the District, with drought conditions in parts of northwestern Kansas into southeastern Nebraska and western Iowa becoming severe to extreme. The Midwest weather began to change to a cooler and wetter regime in October 2000, and very cold weather developed in November and December. By the end of the year, drought conditions had become restricted to southeast Nebraska.

December 2000 was the second coldest December since 1895 in Missouri. The cold weather combined with strong winds in the last two weeks of December to produce an early ice jam on the Missouri River above Sioux City, partially blocking the flow of the river. On December 18, the river stage on the Missouri River at Kansas City fell to the lowest stage in recent years. This resulted in the temporary shutdown of the Nearman power plant a few miles upstream of Kansas City when the river level dropped below the plant water intake. Although other municipal and industrial facilities experienced low flows, the Nearman plant was the only one to shut down.

Overall, National Climatic Data Center summary reports showed that the District weather for 2000 was somewhat warmer and drier than normal. Regarding temperature, the year ranked as about the 25$^{th}$ warmest out of 106 years. Regarding precipitation, the year ranked as about the 30$^{th}$ driest in that period. Nevertheless, stream flows remained unusually low throughout the year, continuing the hydrologic drought. Calendar year inflows to the Federal lake projects in the District fell to just 34 percent of normal. Milford and Rathbun Lakes did not refill to their multipurpose levels until early July 2000. Most Bureau of Reclamation (Reclamation) lakes in the District, along with two Corps lakes, Stockton and Long Branch, did not refill at all in 2000. Beginning in the spring of 2000, the State of Kansas requested releases from its contracted water supply storage at Melvern and Pomona Lakes for the first time since the assurance districts were formed in the early 1990's. Water supply releases from State contracted storage continued until September 2000 at Melvern and Pomona and until February 2001 from Milford Lake. The 5-year periodic inspections at Milford and Tuttle Creek Lakes, originally scheduled for the summer of 2000, were postponed until FY 2001 due to concerns about local water systems supplied by releases from the dams. By January 2001, Long Branch Lake in Missouri fell to its lowest pool elevation ever.

For the Missouri River Basin as a whole, disappointing mountain and plains snowmelt and below normal precipitation produced the lowest annual runoff since 1992. The annual runoff above Sioux City, Iowa, was 16.5 million acre feet (MAF), 65 percent of the normal 25.2 MAF. The Corps Reservoir Control Center in Omaha was able to maintain a full-length navigation season, but flow support was reduced to 1,500 cubic feet per second (cfs) below the full service level for the second half of the season. This was equivalent to a support level of 39,500 cfs at Kansas City.

In April 2000, Missouri and Iowa activated their state drought committees, followed by Kansas and Nebraska in May and June. The District Emergency Management Office provided representatives to the Kansas and Missouri committees and some technical assistance. Nebraska and Iowa requests for assistance at Kansas City District projects in their states were coordinated through sister district offices. For instance, the Rock Island District representative assisted the State of Iowa in a request for special operations at Rathbun Lake. However, the primary impact of the first-year drought conditions was to local water supplies dependent on flows in smaller rivers and streams. By the end of the year, most of these problems had been resolved. No emergency water supplies were requested or provided from Kansas City District lakes.

During the first half of 2001 through July, more normal conditions returned to most of the District except the western third of Kansas. February was wet, with minor to moderate flooding in Missouri and eastern Kansas. March through May had unusually variable weather, with some very warm periods in April through early May. For central and eastern portions of the District late May and June were unusually wet, with four minor to moderate flooding events. In June, record flooding occurred on the South Grand River near Urich, Missouri, and on Stranger Creek at Easton, Kansas. In western Kansas, temperatures were generally above normal for the first half of 2001 except February, and precipitation was a little below normal for the period. Streamflows improved throughout the District, but flooding rainstorms remained infrequent. For the reporting year through July 2001, inflows to District lakes and reservoirs improved to 82 percent of normal, although they would have been closer to 60 percent if not for almost double the normal inflows in June. Hydropower production at Harry S. Truman Reservoir and Stockton Lake for the reporting year ending in July improved slightly to 34 percent of normal from 20 percent of normal during the previous reporting period.

The second half of 2001 continued the trend of variable weather, with mild and generally drying conditions. September was the only month with above average stream flows, and that was limited to central and eastern Kansas and northwest Missouri. October was cool and dry. November and December closed out the year with much above normal temperatures and dry conditions, in contrast to one year earlier. November 2001 was the warmest November on record for the Midwest. Abnormally dry to moderate drought conditions as measured by the Drought Monitor spread from Texas into the southern half of Kansas and into central Missouri, although District long term drought conditions as measured by the Palmer index remained close to normal.

For the calendar year 2001 through December, preliminary reports from the National Climatic Data Center indicate that temperatures and precipitation over the District were a little above normal, with the driest conditions being in western Kansas and the wettest conditions being in northwestern Missouri. Kansas City experienced its third wettest year on record, although as noted earlier there were few flooding rainstorms. Calendar year inflows to District lake projects improved to 92 percent of normal. For the Missouri River Basin as a whole, the

Corps Reservoir Control Center reported that the calendar year runoff above Sioux City was 22.5 MAF in 2001, or 89 percent of normal. Much better than normal spring runoff from the plains states partially made up for a lack of snow in the mountains. However, there was no year-to-year recovery in the pool storage at the main stem dams. Releases from the dams provided a full length navigation season, but the support level was set at 3,000 cfs below full service flows. This was equivalent to 38,000 cfs at Kansas City.

## PROJECT ACCOMPLISHMENTS.

Operating purposes at storage projects in the Kansas City District include flood control, irrigation, water supply, low flow and navigation supplementation, water quality, hydroelectric power, recreation, and fish and wildlife. Project accomplishments in each of these functional areas, for the period covered by this report, are described briefly in the following subparagraphs.

### *Flood Control.*

Stream flow regulation by storage projects in the Kansas City District began with the closure of Kanopolis Lake in February 1948. By July of that year, Kanopolis also provided the first flood control storage, benefiting downstream damage centers. Since this initial impoundment, stream flow regulation by District projects has produced flood reduction benefits estimated in the millions of dollars annually. In addition to the Corps lake projects, local protection projects in the form of levees, floodwalls, and channel improvements also have provided flood reduction benefits amounting to millions of dollars. Federal and private agricultural levees along with temporary storage of flood flows in the main stem reservoir system above Sioux City provide additional benefits within the District.

**Table 1: Flood Reduction Benefits**
**October 1, 2000 through September 30, 2001**

| Project | Fiscal Year 2001 | Cumulative |
|---|---|---|
| **Clinton Lake, KS** | $19,621,000 | $813,002,000 |
| **Harlan County Lake, NE** | $1,943,000 | $150,014,000 |
| **Harry S Truman Resv., MO** | $1,333,000 | $1,837,978,000 |
| **Hillsdale Lake, KS** | $30,000 | $30,749,000 |
| **Kanopolis Lake, KS** | $5,046,000 | $1,159,697,000 |
| **Little Blue River Lakes, MO** | $0 | $50,813,000 |
| **Long Branch Lake, MO** | $165,000 | $45,083,000 |
| **Melvern Lake, KS** | $804,000 | $148,232,000 |
| **Milford Lake, KS** | $18,853,000 | $939,924,000 |
| **Perry Lake, KS** | $158,860,000 | $4,164,234,000 |
| **Pomme De Terre Lake, MO** | $71,000 | $65,643,000 |
| **Pomona Lake, KS** | $761,000 | $152,037,000 |
| **Rathbun Lake, IA** | $1,190,000 | $142,288,000 |
| **Smithville Lake, MO** | $29,254,000 | $514,638,000 |
| **Stockton Lake, MO** | $100,000 | $200,439,000 |
| **Tuttle Creek Lake, KS** | $45,013,000 | $3,946,808,000 |
| **Wilson Lake, KS** | $36,653,000 | $1,372,939,000 |
| **TOTALS** | **$319,697,000** | **$15,734,518,000** |
| Oct 1, 1999, to Sep 30, 2000 | $2,927,000 | $15,414,821,000 |
| 10-Year Average (1992-01) | $1,398,256,500 | |

For the reporting period August 2000 through the end of 2001, there were only scattered reports of minor to moderate flooding mostly due to spring and summer convective activity. Major flooding was limited to isolated locations in June 2001. Record flooding occurred on the South Grand River near Urich, Missouri, on June 7th, and on the Stranger Creek at Easton, Kansas, on June 20th. The flooding at Easton inundated most of the town. Smithville, Missouri, suffered moderate flooding due to a storm on September 17th.

Flood reduction benefits during Fiscal Year 2001 (October 1, 2000, through September 30, 2001) credited to all Corps lake projects in the District were $319,697,000. This total is about a quarter of the long-term average, but well above the previous fiscal year. The lower totals are primarily attributable to the drought conditions. Table 1 lists the flood reduction

benefits credited to the Corps lake projects in the District. When the additional benefits from levees, the main stem reservoirs, and the regulation of flood control storage in the Bureau of Reclamation lake projects in the District are included, flood reduction benefits in the District totaled $464,445,000.

***Irrigation.***

Carryover storage at Bureau of Reclamation lake projects and Harlan County Lake (Corps of Engineers) was generally near or above normal at the end of the 1999 irrigation season with the exception of Swanson Lake and Bonny, Enders, and Lovewell Reservoirs. Precipitation at the project dams during 2000 ranged from 51 percent of normal at Lovewell Dam to 119 percent of normal at Cedar Bluff Dam. The year 2000 inflow was below the dry year forecast and the lowest ever recorded at Bonny and Enders Reservoirs and at Swanson and Hugh Butler Lakes. Lovewell Reservoir and Waconda, Harlan County, and Harry Strunk Lakes had inflows between the dry- and normal-year forecasts. Keith Sebelius Lake and Kirwin, Webster, and Cedar Bluff Reservoirs had inflows between the normal and wet year forecasts. Despite the relatively dry conditions, especially during the spring of 2000, only Enders Reservoir did not have sufficient storage to provide water users with a full water supply at the beginning of the 2000 irrigation season. The conservation pools at Harry Strunk, Harlan County, Lovewell, Kirwin, Webster, and Cedar Bluff completely refilled, and small flood control releases were needed from Harry Strunk and Harlan County Lakes, and Webster and Cedar Bluff Reservoirs.

Warm and dry conditions during the summer of 2000 led to high irrigation demands that significantly reduced storage in most reservoirs. Carryover storage at the end of the 2000 irrigation season ended below normal at most projects, with the exception of Keith Sebelius Lake, and Kirwin, Webster, and Cedar Bluff Reservoirs. Total carryover storage at the irrigation projects was 855,000 acre-feet (AF) at the end of September 2000, compared to 1,060,000 AF at the end of September 1999.

During calendar year 2000, the latest period for which final figures are available, the eleven Reclamation reservoirs in the Kansas River basin, plus the Corp's Harlan County Lake, provided 305,189 AF of irrigation water to 151,857acres of project lands. This compares to 260,041 AF of irrigation water provided to 150,840 acres during calendar year 1999.

The State of Colorado makes Bonny Reservoir storage water available to Hale Ditch and other natural flow appropriators under short-term water service contracts. Most of the 700 acres served by Hale Ditch are now owned and operated by the Colorado Department of Natural Resources, Division of Wildlife. During 2000, at the request of the State of Colorado, 2,476 AF of water were diverted to Hale Ditch.

Inflows during the winter of 2000 and the spring of 2001 generally continued below normal. At the beginning of the 2001 irrigation season, only Harry Strunk, Harlan County, Lovewell, Webster, Waconda, and Cedar Bluff had almost or completely refilled. Minor flood control releases were needed from Harry Strunk and Waconda Lakes and Lovewell Reservoir. Details on the 2001 irrigation season will not be available until the next Annual Report.

***Municipal and Industrial Water Supply, and Water Quality Enhancement.***

Water supply contracts for lake storage space, annual withdrawals, or surplus water exist between the Corps of Engineers and the State of Kansas and 12 other municipalities and rural

water districts within Kansas, Missouri, and Iowa. The State of Kansas in turn contracts with a large number of municipalities and industrial sites to supply water from the State's contracted storage space through the water assurance and water marketing programs. To date, assurance districts have been formed for users in the lower Kansas River and the State of Kansas portion of the Marais des Cygnes River. Water is supplied within the limits of each contract through designated lake releases or from intakes located on the lake at the following projects: Kanopolis, Milford, Tuttle Creek, Perry, Clinton, Melvern, Pomona, Hillsdale, Smithville, Longview, Rathbun, Long Branch, Stockton, and Harry S. Truman. Most of the municipalities and rural water districts holding contracts with the Corps utilize the available water annually.

Due to the drought conditions in 2000, the State of Kansas called for releases from its contracted water supply storage at Milford for the first time since the early 1990's, and from Tuttle Creek, Perry, Melvern, and Pomona for the first time since the assurance districts were formed. Beginning on June 13, 2000, the Kansas Water Office requested additional releases of 50 cfs from Milford Lake for a downstream water marketing contract holder. The additional releases from Milford Lake continued intermittently until February 16th, 2001. The State of Kansas again requested a 52 cfs release from Milford beginning November 9, 2001, continuing until December 31, 2001. Beginning November 9, 2000, the State of Kansas requested that releases be made from contracted storage in Perry, Tuttle Creek, and Milford lakes to support flow targets of up to 1000 cfs at Desoto for the Kansas River Water Assurance District. Additional releases above those needed to support downstream water quality targets ranged from 0 to 200 cfs and continued until February 16, 2001. Flood control releases from Wilson and Kanopolis were also regulated during this period to support flows on the lower Kansas River. Beginning on June 7, 2000, the Kansas Water Office requested additional releases of up to 35 cfs from Pomona Lake for the Marais des Cygnes Water Assurance District. The additional releases from Pomona Lake continued intermittently until September 21, 2000. The Kansas Water Office also requested an additional release of 25 cfs from the Melvern Lake contracted storage for a brief period in August 2000 for the same purpose.

Three municipalities and one rural water district have executed water service contracts for full or supplemental water supplies from three Reclamation reservoirs. A contract with the City of Norton, Kansas, provides for a maximum annual usage of 1,600 AF from Keith Sebelius Lake (Norton Dam). A contract with the City of Beloit, Kansas, provides for a maximum annual usage of 2,000 AF from Waconda Lake. Waconda Lake also provides up to 1,009 AF of water for a contract with the Mitchell County Rural Water District No. 2. A contract with the City of Russell, Kansas, provides for a maximum annual usage of 2,000 AF from Cedar Bluff Reservoir.

During the calendar year 2000, the City of Norton used 550 AF of municipal water from Keith Sebelius Lake. No storage releases were made from Waconda Lake for the City of Beloit; however, 3,316 AF was bypassed for water quality control as directed by the Kansas State Water Commissioner. Waconda releases also included 747 AF to the Mitchell County Rural Water District No. 2. No releases were made from Cedar Bluff Reservoir for the City of Russell. The State of Kansas used the fish hatchery below Cedar Bluff Dam for nurturing Canadian Geese. Approximately 369 AF of water were released from Cedar Bluff Reservoir in 2000 for use at the fish hatchery.

The Corps Reservoir Control Center in Omaha is responsible for regulating the Missouri River main stem reservoirs to provide minimum flows on the Missouri River needed for municipal and industrial water supply intakes and water quality enhancement. Years ago, winter

releases necessary to maintain flows of up to 5,400 cfs at Kansas City were considered sufficient for both water quality and water supply purposes. However, much of the Missouri River channel has degraded during the intervening high flow years, resulting in river stages that are now lower than they used to be for a given river flow. River flows considered sufficient 40 years ago would now result in operational problems at many water intakes along the river. This is considered a matter of intake elevations or access to the available water supply, not a problem with an insufficient water supply. When water is available, the Reservoir Control Center attempts to regulate Gavins Point Dam releases to maintain a minimum release of 10,000 cfs to 13,000 cfs in recent dry years to reduce the impacts of the river channel degradation. A release at this level would still be considered a water conservation measure, since minimum releases in normal water years are in the range of 18,000 cfs. Actual releases during the winter are typically varied up or down from these values as needed to manage icing problems in the reach from Gavins Point to Kansas City.

In mid-December 2000, record cold weather and icy winds led to the formation of an ice jam above Sioux City and a reduction in river flows at Kansas City to about 14,000 cfs at one point. Although this was well above previous record low flows, the river stages during this low flow period were among the lowest ever recorded, due to channel degradation that has occurred in the last 50 years. Many municipal water supply intakes were endangered, but all managed to get sufficient water for winter needs. Two power plants, one near Sioux City and the BPU Nearman Plant above Kansas City, temporarily shut down. The Nearman Plant, which is one of two primary power plants supplying Wyandotte County, Kansas, lost cooling water on December 14. The Reservoir Control Center gradually increased Gavins Point releases from 12,000 cfs to 16,000 cfs to encourage the formation of an ice bridge at the site of the ice jam. This operation eventually succeeded, but river flows remained at a depressed level until mid-January 2001. The Reservoir Control Center was unable to increase releases more without creating a danger of breaking up the ice jam, which would have moved the ice downstream and possibly created a worse situation. As the sag in river flows worked downstream, an Ameren power plant upstream of Hermann, Missouri, was also in danger of shutting down. However, Ameren was able to make up the deficit with supplemental releases from its Lake of the Ozarks on the Osage River days until Missouri River flows recovered.

Water Management staff were in contact with BPU personnel from the time of the shutdown of the Nearman plant on December 14. BPU then requested additional Gavins Point releases and technical assistance from the Kansas City District. The Reservoir Control Center was unable to grant the level of increased releases requested by BPU, but the District's Emergency Management Branch organized a technical assistance team for BPU. BPU eventually decided to install a temporary system of protective booms and submersible pumps mounted on barges to get water into their plant intake. BPU succeeded in restoring partial service to the plant on December 22 and full service on December 27. The temporary system of barges and submersible pumps was removed before the beginning of the 2001 navigation season. BPU expects to have an improved system of barges and pumps available for immediate installation if low water events occur in the future.

Recommendations for minimum stream flows to benefit stream sanitation and for the maintenance of desirable water quality standards were originally established by the U.S. Public Health Service for many river reaches below proposed dams in the District. These recommendations were then utilized to establish minimum release requirements for many of the

District lake projects. The minimum release standards set by the Corps water control plans are usually less than the minimum desirable stream flows set by state water authorities. The latter are intended to satisfy water right holders and fish and wildlife flow standards. In some cases, specific water quality storage allocations were included in the project planning to increase the reliability of the minimum flow releases. Depending on the project, the minimum release quantities may be constant through the year, or they may vary seasonally or vary depending on the amount of current lake storage. Minimum releases for the purposes of downstream quality control and stream sanitation range from 3 cfs during the winter months at Hillsdale Lake to 100 cfs at Tuttle Creek Lake. Large minimum flow releases during certain seasons are also included in the water level management plan for Pomme de Terre Lake and in an agreement with the State of Missouri at Harry S. Truman Reservoir. Additional releases are made from Tuttle Creek, Milford, and Perry Lakes for water quality purposes during periods of low flow on the Kansas River. Project releases may be reduced below minimum requirements for brief periods due to construction, periodic inspections, or emergencies, for instance a downstream drowning. Seepage is generally considered sufficient to meet minimum flow requirements downstream at most Reclamation dams.

***Navigation.***

Releases from the Missouri River main stem reservoir system are designed to provide equitable service to navigation and other project purposes, while at the same time recognizing the important flood control functions of the system. Navigation on the Missouri is limited to the ice-free season, with a full season normally extending from April 1 to December 1 at the mouth. Operating experience plus numerous studies have indicated that flows of 35,000 cfs at Kansas City are the minimum that will permit navigation. Groundings can occur with flows of that magnitude, and dredging may be needed to alleviate local problems. Therefore, an additional flow of 6,000 cfs above the minimum service target has been set as the "full service" level for the navigation function. Thus, a full-service target flow of 41,000 cfs at Kansas City is considered adequate to maintain the designed 9-foot by 300-foot channel with little or no dredging.

In normal times, power releases from Gavins Point Dam on the Missouri River above Omaha, plus local inflows between Gavins Point and Kansas City, keep navigation flows at the full service level through the reach from Kansas City to the mouth. In years of excess water supply, releases greater than those needed to maintain full service navigation requirements are made from the main stem reservoirs to evacuate flood control storage accumulated in the spring and early summer. When an abundance of water is available, the season is often extended an additional 10 days at the end of the season, ice conditions permitting. The decision to extend the season is based on both main stem reservoir system storage and forecast annual basin runoff, the guidelines for which are described in the Missouri River Basin Master Manual.

The 1999 spring runoff for the Missouri River above Sioux City was well above normal, resulting in good carryover storage behind the main stem dams going into the 2000 navigation season. However, drought conditions became established throughout the basin by the winter of 1999-2000, and disappointing mountain and plains snowmelt and below normal precipitation produced the lowest annual runoff in the Missouri River Basin as a whole since 1992. The calendar year 2000 runoff above Sioux City, Iowa, was just 16.5 MAF, 65 percent of the normal 25.2 MAF. Due to adequate carryover storage, the Corps Reservoir Control Center was able to maintain a full-length navigation season in 2000, but flow support was reduced to 1,500 cfs

below the full service level, equivalent to a target flow of 39,500 cfs at Kansas City, for the second half of the season.

Relatively dry conditions continued into 2001 in the upper portion of the Missouri River Basin. The winter of 2000-01 again produced a less than normal mountain snow pack, but the plains snow pack was greater than normal. The net result was a 2001 calendar year runoff of 22.5 MAF for the Missouri River above Sioux City, 89 percent of the normal 25.2 MAF. However, there was no year-to-year recovery in the pool storage at the main stem dams going into the 2001 navigation season. Releases from the dams provided a full-length navigation season, but the support level was set at 3,000 cfs below full service, equivalent to 38,000 cfs at Kansas City.

Releases for navigation supplementation from Kansas River basin lakes are not required when basin runoff is normal or higher than normal, as it was through most of the 1990's. However, during years of below normal water supply, Kansas lakes are at times called upon to supplement Missouri River flows below Kansas City in order to meet the navigation requirement and to conserve water in the main stem lakes. The decision to make supplementation releases usually occurs when the local natural inflow from Nebraska City to Kansas City (including the Kansas River) is less than 4,000 cfs. Guidelines for navigation supplementation releases are contained in existing project and basin water control manuals. The manuals allow additional releases from Milford, Tuttle Creek, and Perry Lakes of up to the deficit in inflows between Nebraska City and Kansas City, as requested by the Reservoir Control Center. However, in recent years the Reservoir Control Center has limited their request to a maximum of 2,000 cfs.

Beginning in July 2000, the Reservoir Control Center requested that Kansas City District supplement the low flows on the Missouri River by maintaining a target flow of 2,000 cfs at DeSoto. However, releases from the Milford, Tuttle Creek, and Perry Lakes were restricted due to special operations for endangered and threatened bird species along the Kansas River. These operations were required under the Endangered Species Act and took precedence over navigation supplementation releases. After the end of the nesting season in late August, Tuttle Creek Lake releases were increased first to evacuate excess flood control storage and then to supplement Missouri River flows. Supplemental releases reached a maximum of about 1,200 cfs above what was needed to maintain water quality flow requirements. Tuttle Creek Lake dropped to an elevation of 1070, five feet below its multipurpose elevation but within the guidelines established in the water control manuals. On September 29, 2000, the supplemental releases were stopped in accordance with a judicial temporary restraining order obtained by the State of Kansas. The deficit in Missouri River inflows was then met by increasing Gavins Point releases.

With the dry upper basin conditions continuing in 2001, the Reservoir Control Center again requested that the District provide supplemental releases from the Kansas River lakes to maintain a target flow of 2,000 cfs at DeSoto. As in 2000, releases from the lakes were initially restricted due to the special operations for endangered and threatened bird species along the Kansas River. Upon the termination of those operations in late August, Milford, Tuttle Creek, and Perry Lakes all had flood control storage available for supplemental releases. Since more normal flows from other tributaries to the Kansas River were now occurring, the District was able to attain the requested target flows through the navigation season by limiting releases to those necessary to evacuate flood control storage in the lakes. No supplemental releases were taken from multipurpose storage in 2001.

***Hydropower.***

Hydropower can be generated at two Kansas City District projects. Harry S. Truman Dam has six units with a rated capacity of 160 megawatts, and a maximum peaking generation rate of 180 megawatts. Due to downstream channel capacity limitations only about four units with a capacity of 120 megawatts are normally operated for extended periods. Releases scheduled for the Harry S. Truman hydroelectric plant anticipate peaking power generation primarily during the months of June through September, with additional generation at other times of the year as water is available and there is a need. Stockton Dam has a single unit rated at 45.2 megawatts. Normal operation of the Stockton hydroelectric facility consists of peaking power generation at a rate of 40 to 45 megawatts for a period of 6 to 10 hours daily throughout the workweek. Continuous power operation at Stockton is restricted by downstream channel capacities that limit tailwater elevations to 777.0 feet and Highway "J" stages to a maximum reading of 17.5 feet. Power from Stockton and Harry S. Truman is marketed by the Southwestern Power Administration (SWPA), and their dispatchers schedule power releases from the dams in accordance with guidelines in the water control manuals and within flood control requirements set by the Water Management Section.

The Stockton unit was available for full service in all months except May 2001, when it was taken down for annual maintenance and repair of cavitation damage on the turbine blades. Prior to March 1, 2001, power from Stockton was scheduled by Associated Electric Cooperative, Inc. (AECI) under contract from SWPA. That contract ended on February 28, after which the project became part of Southwestern's interconnected system. AECI continued to contract for power from SWPA, so the change has little impact on system resources and loads. Net generation by the Stockton plant during this reporting period August 2000 to July 2001 totaled 24,312 megawatt-hours.

At the Harry S. Truman power plant, five of the six units are normally available for power generation. Annual maintenance and unscheduled outages often result in one or more units out of service at any one time. During this reporting period, units 3, 4, and 5 were taken offline for varying periods for maintenance. A Memorandum of Agreement between Ameren/UE, operators of Lake of the Ozarks, and the Corps was approved in June 1995, confirming most provisions stipulated in an Interim Operating Plan approved in October 1989. This MOU restricts power generation to four units during the week and three units on weekends and holidays. During the period December through February, five units may be operated during the weekdays (total time limited to 600 hours per year) and three units on weekends. The tailwater elevation measured at the Highway 7 Bridge at Warsaw is limited to a maximum of 662.5 feet, Union Electric datum, during five-unit releases from the power pool. In a power emergency, SWPA may call for the full capacity of the project. At no time will power releases for power generation exceed an elevation of 664.0 feet at the Highway 7 Bridge at Warsaw. When the Harry S. Truman pool elevation is above 710 feet, a minimum of one unit is operated continuously. When the pool elevation is between 706 and 710 feet, a minimum of one half unit is operated continuously during the downstream fish spawning season March through May. When the pool elevation is below 706 feet, SWPA is only obliged to pass inflows resulting from upstream lake releases during the fish spawning season. Net generation by the Harry S. Truman plant during this reporting period August 2000 to July 2001 totaled 197,103 megawatt-hours.

Inflows to Harry S. Truman and Stockton improved to 68 percent of normal for the reporting period, compared to 35 percent of normal for the previous reporting period ending July

2000. Total generation at Harry S. Truman and Stockton for this reporting period improved to 34 percent of the long-term average compared to 20 percent for the previous reporting period.

***Fish and Wildlife.***

Water level management plans, which include the fluctuation of pool levels at various times of the year for the enhancement of fish and migrating waterfowl, are proposed by the respective state resource agencies annually for most Corps of Engineers and Bureau of Reclamation projects. In Kansas the coordinating agency is the Kansas Water Office; in Missouri the coordinating agency is the Department of Conservation; and in Iowa the coordinating agency is the Department of Natural Resources. The proposals generally include a winter drawdown from higher fall levels to reduce ice damage along shorelines and to provide buffer space for spring rains, a slow spring rise to enhance fish spawning, a summer level for recreation, and a higher fall level to benefit waterfowl habitat and hunter access.

When evaluating the proposals, the Water Management Section staff considers the impacts of the proposal on other project purposes including flood control, water supply, water quality, recreation, and hydropower. Water level management plans are treated as water control plan deviations, with approval required from the Northwestern Division (Division) office. During the August 2000 to July 2001 reporting period, water level management plans were only approved for selected lakes in Missouri, including Smithville, Pomme de Terre, Stockton, and Long Branch. Plans for Corps and Reclamation lakes in Kansas were last approved for water year 1999. A State of Kansas plan for the 2000-01 water year was approved by the Division office, but it was withdrawn at the request of the State prior to implementation. A plan for Rathbun in Iowa was last approved for the calendar year 1999, but low inflows prevented the fall rise portion of the plan.

In July 2000, the Division office approved a deviation to allow Kirwin, Webster, Waconda, Norton, Kanopolis, Milford, Clinton, Pomona, Melvern, and Hillsdale lakes in Kansas, and Smithville and Pomme de Terre lakes in Missouri to be operated at either slightly higher than normal summer levels and/or to begin filling to the fall levels anticipated to be approved for the 2000-01 plan proposals. One of the reasons for the approval was again the drought conditions existing in 2000 and the possibility that fall inflows would be insufficient to provide a normal fall rise in the pools. Only Smithville and Kanopolis actually received sufficient inflows to provide a fall rise in 2000.

Special lower Kansas River reservoir release operations required under the Endangered Species Act are described in a later section on Project Operations. These are not part of the existing water control plans.

***Recreation.***

Recreational use of the Corps lakes is a highly visible and important function. Recreational use is enhanced when the lakes are operated close to their normal or multipurpose pool levels. During flood years when large quantities of water are stored in the flood pools and during drought years when the lake levels drop, then access to the lakes and the shoreline facilities, as well as the quality of the experience, is reduced. Park managers at the projects are also concerned about related factors such as facility maintenance and water quality. The fish and wildlife function is closely related to the recreation experience, and coordination with state and county park officials for park management is important. As one would expect, projects close to metropolitan areas tend to experience the highest recreational demand. Fiscal Year 2001 visitation figures compiled for the Corps lakes in the Kansas City District indicate an increase in visitation hours at 11 of the 18 lake projects. Total visitation hours for the 18 projects are slightly less than the previous year, but fee collections were slightly more. A list by projects of the visitation totals at Corps lakes is shown in Table 2. Project park facilities at Blue Springs, Hillsdale, Long Branch, Longview, and Smithville are leased to county or state agencies. The fees collected at those projects are only for national passes such as the Golden Age Passport. Blue Springs Lake does not have a fee collection office.

**Table 2: Visitation and Fee Collection**
**October 1, 2000 through September 30, 2001**

| Project | Visitation (Visitor Hours) | Recreational Fees Collected |
|---|---|---|
| **Blue Springs Lake, MO** | 1,417,534 | $0 |
| **Clinton Lake, KS** | 7,043,736 | $126,212 |
| **Harlan County Lake, NE** | 8,316,203 | $136,868 |
| **Harry S. Truman Resv., MO** | 11,481,823 | $500,087 |
| **Hillsdale Lake, KS** | 2,998,896 | $678 |
| **Kanopolis Lake, KS** | 1,435,318 | $73,356 |
| **Long Branch Lake, MO** | 1,580,952 | $145 |
| **Longview Lake, MO** | 2,291,840 | $1,188 |
| **Melvern Lake, KS** | 4,574,928 | $191,507 |
| **Milford Lake, KS** | 5,116,211 | $125,059 |
| **Perry Lake, KS** | 4,512,156 | $171,240 |
| **Pomme de Terre Lake, MO** | 14,845,531 | $264,318 |
| **Pomona Lake, KS** | 3,456,012 | $89,805 |
| **Rathbun Lake, IA** | 4,558,136 | $236,228 |
| **Smithville Lake, MO** | 7,129,236 | $662 |
| **Stockton Lake, MO** | 7,263,884 | $349,966 |
| **Tuttle Creek Lake, KS** | 2,821,676 | $14,753 |
| **Wilson Lake, KS** | 2,281,392 | $100,432 |
| **TOTALS** | **93,125,464** | **$2,382,504** |
| **Oct 1, 1999, to Sep 30, 2000** | **94,855,599** | **$2,310,422** |
| **5-year Average (1997-2001)** | **95,288,588** | **$2,276,259** |

## PROJECT OPERATIONS.

Actual operations for the 2000-01 reporting year and the proposed operations through calendar year 2002 are discussed in the following subsections.

***Corps of Engineer Lakes - August 1, 2000 through July 31, 2001.***

With the exception of special operations required under the Endangered Species Act, Corps lakes within the Kansas City District were regulated in accordance with normal procedures during the period covered by this report. Appendix A includes pool elevation hydrographs and monthly inflow graphs at all Corps projects in the District, along with summary data providing an historical perspective.

During the past reporting period from August 2000 to July 2001, most of the District experienced slightly above normal rainfall, following a dry year for the 12 months preceding August 2000. However, there were few flooding rains, and inflow to the District lakes and reservoirs only averaged about 82 percent of normal. Inflows were close to normal in Kansas and Nebraska and less than normal in Missouri and Iowa. This compares to inflows of 41

percent of normal for the previous reporting period preceding August 2000. At the beginning of this reporting period on August 1, 2000, twelve Corps lakes and one Reclamation lake had minor amounts of storage in their flood pools. Tuttle Creek Lake had filled about 9 percent of its available flood control space due to operations for endangered species. However, most pools lost storage during the fall, and by the end of the calendar year the Tuttle Creek pool elevation had dropped 17 feet and virtually all of the flood control storage in other lakes had been released. Flood control storage was again accumulated during the more normal 2001 runoff season. At the end of the period on July 31, 2001, sixteen Corps lakes and one Reclamation lake had some flood control storage. Tuttle Creek storage occupied 8 percent of its available flood control space. Other lakes had accumulated minor amounts of storage mainly due to seasonal operations for water level management plans. Again, the accumulated flood control storage was mostly evacuated by the end of 2001 in accordance with normal seasonal fluctuation plans. None of the Corps or Reclamation lakes in the District experienced record high pools during this reporting period. Due to the drought conditions, Long Branch Lake dropped to a record low elevation of 783.70 on January 12, 2001, or more than 7 feet below its full multipurpose pool level of 791.0.

In 2000, Water Management Section staff participated on District drought response teams coordinated by the District's Emergency Management Branch. Water Management staff were occasionally called upon to meet with the State of Missouri Drought Assessment Committee, and Water Management staff provided coordination with representatives from sister districts who attended state committee meetings in Iowa and Nebraska. On June 15th, the Rock Island District assisted in a request from the State of Iowa Drought Advisory Council to accumulate up to two feet of water in Rathbun Lake above its normal multipurpose pool level. This was approved by the Northwestern Division office as a water control plan deviation request, effective through the end of the year. However, inflows were insufficient to provide the desired storage. In August and September, Water Management staff assisted District drought team members in coordinating the postponement of periodic inspections at Tuttle Creek and Milford due to water supply concerns. The Milford postponement was due to water supply concerns at Junction City. Other drought related actions included supplemental releases from contract water supply storage at a number of projects at the request of the State of Kansas. These were described earlier in the Water Supply discussion.

Operations at Milford and Tuttle Creek Lakes during the May through August periods are affected each year by the presence of two bird species, the Piping Plovers and Least Terns, listed on the Federal threatened and endangered species lists, respectively. The Act requires Federal agencies to ensure that their actions do not jeopardize the continued existence of a threatened or endangered species. In 1994, a population of Least Terns was located nesting on fly-ash spoils at Jeffrey Energy Center near Belvue, Kansas. The high water events of 1993 and 1995 resulted in many newly scoured sandbars along the Kansas River. Least Terns and Piping Plovers were first reported on some of these sandbars in 1995 and 1996. This was the first nesting of the Piping Plover ever recorded in Kansas. Beginning in 1998, the nesting locations were monitored throughout the breeding season to determine productivity by the species. Funding for the 1998 study was provided by the U.S. Fish and Wildlife Service (USFWS), and funding since then has been provided by the District. The District purchased an airboat in this reporting period, which is used by Water Management staff, District biologists, and the USFWS to monitor the bird populations and river conditions. It is also used at other times of the year for low flow surveys on District rivers and to monitor wildlife and wetland areas on the District lakes.

The District has developed a plan of operation to monitor the nesting areas and coordinate lake releases. During the 2000 and 2001 nesting seasons, the District contracted with Dr. Roger Boyd of Baker University in Baldwin, KS, to monitor nesting activities. The District's Environmental Resources Section administered the contract and provided coordination with other agencies, including the U.S. Fish and Wildlife Service. Water Management staff in turn coordinated release decisions with the personnel in Environmental Resources Section and other District elements. In general, bird pairs tend to build their nests very close to the shoreline on scoured sandbars. Dr. Boyd locates the nests, and then the District establishes a maximum target stage at Wamego and Belvue to which Milford and Tuttle Creek lakes are regulated. During flood events, Water Management staff reduce releases from the two lakes in an attempt to keep the Kansas River from exceeding the target stages. Because of the 1 to 2-day travel time it takes for a change in release at the upstream projects to reach the downstream nesting sites, it is not always possible to have an impact on the downstream stages before the local inflows from a rainstorm flood the nesting sites. Nests can also be lost due to inclement weather like hail and from predation. Excess inflows to the lakes are stored in the flood control pools of the two lakes until downstream conditions allow the evacuation of the excess storage. In practice, this operation primarily affects Tuttle Creek Lake since inflows to Milford tend to be minimal during the period of concern. The reproductive success for the last seven years is irregular, but the studies by Dr. Boyd indicate that the success is comparable to other regional nesting sites like the Quivira National Wildlife Refuge.

In 2000, nests were observed at many locations from Wamego down to near Lecompton. The target stage at Wamego was restricted to a maximum of about 5 feet. This was considerably less than the 8-foot target stage in 1999, limiting the maximum discharge at Tuttle Creek to about 3,000 cfs. Releases were reduced when stormy weather was forecast, but the number of storm events was minimal due to the drought. A storm on July 4 resulted in the loss of two nests from uncontrolled inflow below Tuttle Creek, but overall the operations were successful in maintaining the river flows below the target levels at Wamego. Dr. Boyd determined that 11 Tern pairs were able to successfully nest, producing 10 fledged chicks. This was the highest total since 12 successful fledglings in 1998. Tuttle Creek Lake stored a substantial amount of water in its flood pool during the summer, with the pool elevation rising to 1086.4 (multipurpose pool level 1075.0) in late July. Only a minor amount of water was stored in the Milford Lake flood control pool. Restrictions on Tuttle Creek releases were terminated on August 26, 2000.

In 2001, higher river flows prior to the nesting season restricted confirmed nesting locations to the Belvue site about 3 miles downstream of Belvue, Kansas. The first nests were located on May 25, although some of the nests were likely established as early as April 30. The Wamego target for restricting upstream reservoir releases was initially set at a stage of 4.5 feet, rising to 5.5 feet in August. Uncontrolled runoff from storms washed away the nests by the first week in June. The Piping Plovers did not renest after this event. Milford and Tuttle Creek Lakes stored a substantial amount of water during the storm events, and USFWS agreed to a release of the excess storage during the month of June. Seven Least Tern nests were reestablished in July. Most of the nests were destroyed by predators, hail, and uncontrolled runoff by early August. Two nests survived. Dr. Boyd determined that three fledglings probably survived to the end of the season on August 29. Tuttle Creek Lake stored a substantial amount of water in its flood pool during the summer, with the pool elevation rising to 1088.9 in early June, followed by a rise to 1084.5 in early August. Milford rose to 1149.4 (multipurpose pool level 1144.4) in early June, followed by a rise to 1147.9 by the end of August.

After the termination of the special operations for nesting, Milford and Tuttle Creek releases were transitioned into normal operations by evacuating excess flood control storage and providing supplemental releases for Missouri River navigation and Kansas River water quality requirements. These operations were described in previous subsections specific to navigation and water supply.

On July 25, 2000, the Northwestern Division Commander signed a Record of Decision for Harlan County Lake in Nebraska adopting the Bureau of Reclamation's Final Environmental Impact Statement for the Republican River Basin Repayment and Long-Term Water Service Contracts. Harlan County Lake was constructed and operated for flood control, recreation, water quality, fish and wildlife, and irrigation. A substantial portion of the multipurpose pool is allocated to the irrigation function. The signing of the ROD resolved an issue between the Corps and Reclamation regarding operation of the irrigation and sediment storage in the pool dating back to the early years of the project. The ROD provides a plan that protects all project purposes affected by the declining upstream water resources. The water control plan now allows some water for irrigation to be withdrawn from the sediment pool during drought conditions. Water shortages are shared between the various beneficial uses of the project. Following a new sediment survey, a revised lake elevation-area-capacity table was placed into service effective January 2001. A revised Field Working Agreement between the Corps and Reclamation was signed on behalf of the Corps on July 17, 2001. Revisions to the Harlan County Lake Water Control Manual incorporating the changes were approved by the Division on May 10, 2001.

Lake sediment surveys are accomplished, as needed, at most Corps lakes. When the changes in sedimentation are significant, revised lake elevation-area-capacity tables are issued. Besides the revisions at Harlan County Lake noted in the previous paragraph, new tables for Tuttle Creek Lake were placed into use effective February 2001, and the tables for Rathbun Lake were placed into use effective December 2000.

Beginning in 1999, the Emergency Action Plans (EAP's) for all Corps lake projects were revised and distributed to the projects and the public. The EAP's constitute Volume II of each project's Operations and Maintenance Manual. They describe action plans and notification procedures for a range of emergencies, including a dam break scenario. Orientation meetings with local and state officials were completed in 2000. The District completed distribution of the revised plans in 2001. The inundation maps for Tuttle Creek will be revised soon in accordance with a revised hydrologic analysis now being conducted. See a later section on Research and Special Studies for the description of special studies at Tuttle Creek Lake. Water Management staff participated in some of the orientation exercises for the revised plans.

Inspection and maintenance activities at the lake projects occasionally require Water Management involvement. During a 5-year periodic inspection, releases from the affected lake may be stopped in order to perform inspections and maintenance on the outlet stilling basin and downstream channel. During this reporting period, periodic inspections were accomplished at Rathbun (October 2000), Milford (November 2000, delayed from earlier in the summer due to drought concerns), and Tuttle Creek (March 2001, delayed from 2000 due to drought concerns). All three inspections included dewatering of the stilling basins. Service and emergency gate maintenance at both Perry and Tuttle Creek during this reporting period required temporary adjustment of releases from each project. Releases from Tuttle Creek were regulated in an attempt to keep the pool below elevation 1091 to minimize impacts to the contractor. Work on

the gates at Perry required that the pool be lowered below the multipurpose level for the August 2000 to January 2001 period.

Other dam safety concerns for which Water Management staff have provided input include the following: Section staff participated in dam safety training sessions for Wilson and Kanopolis project personnel in February 2001, for Pomona in March 2001, and for Perry, Clinton, and Hillsdale in November 2001. At Wilson Dam, movement has been noted in the stilling basin walls. The movement led to a decision to temporarily remove a portion of the backfill behind the walls. Further repair work is anticipated later in FY 2002. An initial analysis of the Harlan County Dam tainter gates and bearings indicated that inadequate trunnion friction values were used in their design. There are also problems with the chain hoists. In addition, there is a potential for upstream failure of Reclamation dams. On July 31, 2001, the Division office approved a revised interim surcharge operation procedure at Harlan County Dam to reduce the risks to the gates until a more permanent solution can be implemented. The interim procedure increases the flood risks to downstream landowners. A public meeting will be held with downstream interests to inform them of the possibility. Studies are continuing in FY 2002. Studies have also been initiated to evaluate waterstops at Harry S. Truman Dam. Increased flows into the interior galleries were noted during the winter of 2000-01. Relief well rejuvenation and foundation drain cleaning is continuing at a number of projects. During this reporting period, relief wells were rejuvenated at Smithville, Perry, Long Branch, and Wilson. Foundation drain cleaning was accomplished at Harry S. Truman Dam.

***Bureau of Reclamation Projects - August 1, 2000 through July 31, 2001.***

Reservoir operations at the 11 Reclamation projects in the Kansas City District were carried out in accordance with normal regulation procedures during the period covered by this report. At the Reclamation projects, all operations are scheduled for optimum benefits of the authorized project functions. Monthly, or as often as runoff and weather conditions dictate, Reclamation personnel evaluate the carryover storage and estimated inflow at each reservoir to determine whether excess water is anticipated. A rising pool in the spring benefits fish spawning in the lake as well as irrigation storage. Following the irrigation season drawdowns, herbaceous growth along the lake banks benefits fall waterfowl habitat and spring fish habitat. Inflows during the fall, winter, and spring are typically stored. If excess inflow is apparent, controlled releases are made to maximize lake and downstream benefits, including flood control. Appendix B includes pool elevation hydrographs at all Reclamation projects in the District, along with summary data providing an historical perspective.

The regulation of flood control storage in Reclamation reservoirs in the Kansas River basin has been assigned to the Kansas City District Water Management Section. When project inflows are sufficient to produce an encroachment into the flood pool, coordination is immediate between the two Federal agencies, and decisions are made regarding the regulation desired. Regulation orders are issued by Water Management staff to the Reclamation's Water Operations Group at the McCook Field Office in Nebraska. The McCook Field Office is responsible for issuing orders for both flood control and conservation releases to the Reservoir Superintendent. During this reporting period, there were only minor amounts of flood control storage accumulated at Reclamation projects due to the drought. As in the previous reporting year, minor flood control releases were needed from Cedar Bluff Reservoir in 2000, an unusual occurrence. Other lakes making small flood control releases before the beginning of the 2000

irrigation season included Harry Strunk and Harlan County Lakes, and Webster Reservoir. Prior to the 2001 irrigation season, small flood control releases were needed at Harry Strunk and Waconda Lakes, and Lovewell Reservoir.

Details of the 2000 irrigation operations at Reclamation lakes are described in the earlier section on Irrigation. Carryover storage at the end of the 2000 irrigation season was below normal at most projects, with the exception of Keith Sebelius Lake, and Kirwin, Webster, and Cedar Bluff Reservoirs. Inflows during the winter and spring prior to the 2001 irrigation season were generally less than normal. With the most probable inflow conditions, Reclamation expected that irrigation districts would receive full supplies during the 2001 season at all projects except Enders Reservoir. If inflows were less than normal, then irrigation districts taking water from Swanson, Hugh Butler, Harry Strunk, Keith Sebelius, Harlan County, and Lovewell could receive less than full supplies. At the beginning of the 2001 irrigation season, Bonny, Enders, Swanson, Hugh Butler, Keith Sebelius, and Kirwin had not refilled or approached refill. Details on the 2001 irrigation season will not be available until the next Annual Report.

The water service contracts for nine irrigation districts in the Nebraska-Kansas Projects area were scheduled to expire between 2000 and 2007. Some are contracts that were extended temporarily in accordance with a law passed in 1996. The long-term water service contracts with the Frenchman-Cambridge, Frenchman Valley, Kansas Bostwick, Nebraska Bostwick, and Almena Irrigation Districts were renewed on July 25, 2000, confirmed in District Court, and become effective on January 1, 2001. The process for renewing long-term water service contracts with the Kirwin and Webster Irrigation Districts was begun in 1997 but suspended until late in 2000. Renewal of the contracts constitutes an action requiring the preparation of a National Environmental Policy Act (NEPA) compliance document. Completion of the NEPA document, public review, and execution of the contracts is scheduled for early 2002.

Continuing work on rehabilitating all piezometer wells and upgrading the associated equipment was completed by the end of 2001. A program was initiated in 2001 to examine all toe drain systems over the next few years. Minor repair work was accomplished in 2000 at Bonny, Enders, and Waconda. Minor repair work was accomplished in 2001 at Harry Strunk, Swanson, and Kirwin.

The Safety of Dams program has been an important concern at Reclamation projects in recent years. Comprehensive Facility Reviews and Periodic Facility Reviews (comparable to the Corps 5-year Periodic Inspections) were completed at all Reclamation dams in the Kansas City District in 2000. Annual site inspections were completed at each dam in 2001. Emergency Action Plans (EAP) have been updated at all Reclamation projects in recent years. EAP orientation meetings took place in 2000 at all dams except Bonny. Functional exercises of the EAP took place in 2000 at Bonny and in 2001 at Enders and Lovewell. Classroom dam operator training was conducted in February 2001 for all primary and alternate dam operators. This is required training every three years. Reclamation's Denver Technical Center is continuing Safety of Dams investigations at Bonny, Enders, Red Willow, and Norton Dams. Repair work under the Safety of Dams program is now being accomplished at Enders and Red Willow Dams. Emergency radios have been installed at each of the projects as a backup communication system to contact local emergency management officials during emergency events. Revised Standard Operating Procedure (SOP) manuals at Bonny and Cedar Bluff are currently being reviewed, and Reclamation expects they will be republished in 2002. Reclamation is now revising the SOP's for Keith Sebelius (Norton Dam) and Enders.

Lake sediment surveys accomplished in recent years provided updated lake elevation-capacity-area tables at Lovewell Reservoir (effective January 1997), Kirwin and Webster Reservoirs (effective January 1998), Enders Reservoir and Hugh Butler Lake (effective January 1999), and Cedar Bluff Reservoir and Keith Sebelius Lake (effective January 2002).

***Proposed Operations - August 2001 Through Calendar Year 2002.***

Corps and Reclamation storage lakes in the Kansas City District contained a total of 5,801,247 AF of storage on August 1, 2001. This total is 197,654 AF more than the volume in storage on this date one year earlier. Of the total volume in storage, 732,512 AF (13 percent) were contained in the Reclamation lakes and 5,068,735 AF (87 percent) were contained in the Corps projects. The total storage in the Reclamation lakes is a decrease of 7,815 AF compared to August 1, 2000, mainly due to lower than normal inflows and high irrigation demand.

Sixteen of the eighteen Corps lakes and one of the eleven Reclamation lakes in the District contained storage in their flood control pools on August 1, 2001. The occupied flood control storage amounted to 465,652 AF, about 4 percent of the total system flood control space available. This volume compares to 313,182 AF of flood control storage space occupied on August 1, 2000. At both points in time, a large portion of the system flood control storage was accumulated in Tuttle Creek Lake due to release restrictions needed to reduce damage to downstream nesting sites (see the earlier section describing current year operations at Corps projects). In August 2001, another large portion of the flood control storage was contained in Harry S. Truman Reservoir, but only about 4 percent of that project's flood control space was actually occupied. At this time, normal operations are anticipated through calendar year 2002.

The District is seeking approval of documents providing a reallocation of 12,500 AF of multipurpose storage at Kanopolis Lake to water supply storage. The documents, including a draft Reallocation Report, an Environmental Assessment with a Finding of No Significant Impact, and a draft water supply storage agreement with the State of Kansas, are now being considered by the Assistant Secretary of the Army (Civil Works). The District expects that the documents will receive final approval in 2002. The State will then contract with local users for water supply under terms of the State water assurance and water marketing programs.

**MAJOR REGULATION PROBLEMS AND PROPOSED SOLUTIONS.**

During this reporting period, minor deviations from the approved water control plans were obtained for some Corps projects. Deviations in 2000 were primarily related to the drought conditions, while deviations obtained in 2001 were needed to address flooding concerns. In early July 2000, Northwestern Division approved a minor deviation allowing Rathbun Lake to store up to two feet of water in the flood control pool as a water conservation measure requested by the State of Iowa. The deviation was effective through the end of calendar year 2000. In early August 2000, the Division approved a minor deviation allowing the District to hold up to 4.5 feet of additional flood control storage at selected lakes in Missouri and Kansas through September. The deviation was for water conservation purposes and to allow a transition to normal fall operations in lieu of an annual water level management plan for the Kansas lakes.

In 2001, high inflows to Rathbun Lake resulted in the highest March pool elevations ever reached. After the project personnel coordinated with downstream agricultural interests, the Division approved a minor deviation for March through May to allow releases of up to 1,500 cfs from the dam. In June, the Division approved an extension of the deviation through August.

High inflows in May and June 2001 resulted in high pool elevations at Tuttle Creek and Perry Lakes, which created concerns at a time when storage space was needed for operations for endangered/threatened bird species. The Division approved a minor deviation for the month of June allowing a Phase II flow target of 130,000 cfs at Waverly on the Missouri River. This resulted in more timely evacuation of excess flood control storage at the Kansas Basin lakes.

Recent Kansas River regulation concerns led to a decision in 2000 to begin the development of a Kansas River Basin reservoir system simulation model. The model will provide a mechanism for preparing timely and adequate evaluations of different operation procedures and the assessment of reservoir operational impacts on the lower Kansas River. The regulation concerns include managing releases for Least Terns and Piping Plovers as required under the Endangered Species Act, modifying Kansas River operations to conform with recommendations included in a recent U. S. Fish and Wildlife Service Biological Opinion on Missouri River Basin operations, providing releases in the lower Kansas River for water quality and supplemental navigation flows while accommodating increasing water supply needs providing for recreational and fish and wildlife needs on the lakes and downstream of the lakes, evaluating the impacts of lake fluctuation plans proposed by the State in more detail than currently available, and meeting concerns regarding channel capacities, floodplain development, and other changes in operating considerations for flood control.

Funding for the development of a Kansas River system model using the Riverware modeling software was obtained for the 2001 and 2002 fiscal years, and a team has been assembled to begin evaluating problems and reviewing possible solutions. Riverware was developed and is supported by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES), University of Colorado. The system model will be developed as a baseline model and then modified to address alternative operations. Configuration of the physical layer engineering objects such as reservoirs, routing reaches was completed in FY 2001. This physical layer required some program retooling to incorporate in-stream depletions evaluated by the Kansas Water Office. Work has progressed on an operation rule set to define targets and control lake releases in the physical layer. This set consists of gated surcharge rules, flood evacuation rules, low flow rules, navigation targets, and Kansas River Assurance Program accounting rules.

## WATER CONTROL MANUALS.

This section serves to provide the information requested in paragraph 13c of ER 1110-2-240, dated October 8, 1982, regarding the status of water control manuals.

**Table 3: Project Manual Status and Revision Schedule**

| Reservoir/Lake | Stream/River | Owner | Report Status | Submission Schedule |
|---|---|---|---|---|
| **Nebraska** | | | | |
| Master Manual | Republican | CE | Updated final submitted to NWD for review July 28, 1977 | |
| Harlan County | Republican | CE | Revision approved by NWD May 10, 2001 | |
| Harry Strunk | Medicine Creek | BR | Approved by NWD July 12, 1974 | |
| Enders | Frenchman Creek | BR | Approved by NWD March 26, 1973 | |
| Swanson | Republican | BR | Flood Control Regulation approved by OCE October 6, 1969 | |
| Hugh Butler | Red Willow Creek | BR | Flood Control Regulation approved by OCE November 21, 1969 | |
| **Colorado** | | | | |
| Bonny | S. Fork Republican | BR | Approved by OCE October 6, 1969 | |
| **Kansas** | | | | |
| Lovewell | White Rock Creek | BR | Approved by OCE April 9, 1969 subject to comments | |
| Milford | Republican | CE | Approved December 1984. Minor revision approved Jan 1995 | |
| Norton | Prairie Dog Creek | BR | Approved August 28, 1974 | |
| Master Manual | Smoky Hill | CE | Approved March 28, 1975 | |
| Kanopolis | Smoky Hill | CE | Revision submitted to NWD October 30, 1984 | |
| Cedar Bluff | Smoky Hill | BR | Approved by NWD September 25, 1975 | |
| Kirwin | N. Fork Solomon | BR | Approved by NWD February 6, 1974 | |
| Webster | S. Fork Solomon | BR | Approved by NWD July 16, 1975 | |
| Wilson | Saline | CE | Revision submitted to NWD June 13, 1997 | |
| Waconda | Solomon River | BR | Approved by NWD July 12, 1972 | |
| Master Manual | Kansas | CE | Approved by OCE March 22, 1967 subject to comments | |
| Tuttle Creek | Big Blue | CE | Approved April 16, 1974. Minor revision approved January 1995 | |
| Perry | Delaware | CE | Approved July 1973. Minor revision approved January 1995 | |
| Clinton | Wakarusa | CE | Approved February 12, 1980 | |
| Master Manual | Osage River | CE | Approved by OCE Sep 21, 70 subject to NWD, OCE comments | |
| Pomona | 110 Mile Creek | CE | Approved February 1973 | |
| Melvern | Marais Des Cygnes | CE | Approved June 27, 1985 | |
| Hillsdale | Big Bull Creek | CE | Approved June 19, 1985 | March 2002 |
| **Missouri** | | | | |
| Pomme De Terre | Pomme De Terre | CE | Revision submitted to NWD September 1996 | |
| Harry S. Truman | Osage | CE | Interim manual approved by NWD May 12, 1981. Minor revision approved April 1996 | |
| Stockton | Sac | CE | Approved August 21, 1975 | |
| Smithville | Little Platte | CE | Approved August 12, 1979 | |
| Long Branch | E. Fk Ltl. Chariton | CE | Interim manual approved November 21, 1978 | |
| Longview | Little Blue | CE | Approved February 15, 1994 | |
| Blue Springs | E. Fork Little Blue | CE | Approved January 27, 1994 subject to comments. Revision submitted to NWD December 1994 | |
| **Iowa** | | | | |
| Rathbun | Chariton | CE | Approved October 19, 1981 | |

### *Manual Status.*

Water control plans prepared for specific projects and basins within the Kansas City District have been documented in appropriate manuals as directed by paragraph 6c of the above referenced ER. Paragraph 6c also directs that water control plans be revised as necessary to conform with changing requirements resulting from developments in the project area and downstream, improvements in technology, new legislation, or other relevant factors, provided

such revisions comply with existing Federal regulations and established Corps of Engineers policy.

The water control manual for Pomme de Terre Lake was reviewed by the Division and returned for corrections and clarifications on March 18, 1997. The water control manual for Wilson Lake was submitted to the Division for review on June 13, 1997. A revision to the water control manual for Harlan County Lake was approved by the Division on May 10, 2001. The Hillsdale Lake manual is currently being updated. The schedule and status of manuals for all projects is shown on Table 3.

***Other Reports.***

Plates 2A-E list project data showing the date impoundment of storage began, the date the multipurpose pool (the active conservation pool in USBR projects) first filled, and the current status of Standing Instructions for Regulation of Storage in Corps of Engineers Lakes.

As indicated in Engineering Manual 1110-2-3600, it is essential that project operators (dam tenders, operations managers, power plant superintendents) at the various flood control and multiple-purpose reservoirs be supplied with regulation schedules to be followed in case of communication failure. These regulation schedules should be followed in case of communication failure with the headquarters from which instructions are normally issued during flood situations. Standing Instructions have not yet been issued for Harry S. Truman Reservoir, Clinton, Hillsdale, Long Branch, Smithville, Longview, and Blue Springs Lakes.

## HYDROLOGIC DATA COLLECTION.

The primary objectives of Kansas City District's hydrologic data program is to provide information on precipitation and stream flow characteristics occurring over and within a particular area for a given period of time. These data are used for many purposes, including the design, construction, and maintenance of a wide variety of structures in and along streams; the management of lake releases during floods; the production of hydropower; the design and maintenance of navigation facilities; the control of pollution; the management of flood plains; the development of recreational facilities; the design of highway bridges and culverts; the establishing and administering of water rights and compacts; and the resolving of political, social, and legal water problems. As with any program, however, the restraint on funds and manpower, and the usefulness of the data obtained will determine to what extent the program will, or should, be pursued at any particular point in time. The overall program of observing, monitoring, and collecting hydrologic and meteorological data in the District is quite extensive yet flexible to meet operational and economic needs. Brief descriptions of the various types of data collection now being utilized are presented in the following paragraphs.

***Collection and Processing of Water Control Data.***

Hydrologic data such as precipitation, stream flow, and lake information are collected in the Kansas City District by the following: individual observers, Corps project offices, the National Weather Service (NWS), the Geological Survey (USGS), the Bureau of Reclamation, and certain state agencies. Several different methods of communication are used in the Kansas City District to collect these data. Telephone and fax communications are used to collect the data that come directly to the Water Management Section from observers and Corps field personnel. Operational and hydrologic data for the Reclamation projects are transferred by email

or fax from their field office in McCook, Nebraska. Stream flow and stage data are transmitted through a satellite downlink and a Datawise Receive Station from USGS transmitters or directly from automated data collection platforms. NWS precipitation data and river forecasts are transferred automatically between agency computer servers. Weather data, radar observations, and a large amount of subsidiary information are also available through the Internet or direct computer ties. Data received by the District is entered onto the Water Management Section's Unix server database by both automated and manual methods, depending on the data source. Software developed by Water Management Section staff provides a means to view, screen, and process the data for graphical and reporting purposes. The data is then uploaded to the Penstock database located at the Corps Reservoir Control Center in Omaha. Selected data reports are transmitted back to the NWS server at the same time. Once entered into the Division database, the data and reports are available to users Division-wide for forecasting, data listings, reports, bulletins, charts, program processing, and modeling. Daily data and project reports are also available to the public at the Section's web site, http://www.nwk.usace.army.mil/current.html

In 2001, Water Management Section staff initiated an Approved Quality Control Plan to ensure that its data processing, reports, and engineering documents meet District and Corps quality standards. Customers needing Section products on a daily basis include: the Southwestern Power Administration, the National Weather Service, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the States of Kansas, Missouri, Nebraska, and Iowa, and the general public. Corps elements using Section products include the Reservoir Control Center in Omaha, the District's Emergency Management Branch, and the Operation Managers at each lake project.

In order to provide an extended uninterrupted power supply (UPS) during emergency operations, in 2001 the Section acquired the necessary racks and moved its data servers to the secure computer room in the Federal Building. The next step will be to connect the computer room into the portable generator at the emergency operations center.

In 2002, the District and Division software to manage the water control data system will be converted to the Corps of Engineers Water Management System (CWMS), a nation-wide data management platform for the entire Corps. CWMS is an enterprise-wide information technology project, which will standardize all water management offices under one system. CWMS will provide standard tools, database, data sources, model software, and modeling methodology. This system is being implemented on a regional aspect in the Northwestern Division. The final deployment will consist of one regional system deployed on a master server in the Reservoir Control Center and two mirror servers located at Omaha and Kansas City District offices. The automatic data processing infrastructure underlying the CWMS system will be centrally administered by information technology staff in the Division office. The CWMS software configuration will be managed locally at each office.

To support the CWMS deployment, in FY 2001 the Water Management Section acquired a Sun Blade 1000 workstation. The CWMS software including the Oracle database was loaded on this workstation. Staff from the Hydrologic Engineering Center (HEC) provided onsite CWMS training in the District November 14-16, 2001. The CWMS system was initially tested at the Reservoir Control Center. This test discovered that Oracle data replication was not functional with the database design currently used in the region. A solution to this replication discrepancy is planned and budgeted for FY 2002. The Water Management Section staff is currently expanding the configuration of real-time data processing features of CWMS. Also, an

HMS model of the Big Blue Basin above Tuttle Creek Lake is being developed to test the NEXRAD gridded rainfall/runoff modeling capabilities in CWMS. CWMS will be run concurrently with the existing water management system until all mission-critical requirements have been consistently met. At that point, the current system will be retired.

***Automatic Remote Sensors.***

Data Collection Platforms (DCP's) are the primary means by which Kansas City District obtains remote sensing data on stream stages and lake elevations. The DCP is a sophisticated device that collects the information from a USGS manometer and transmits the data to a GOES satellite for subsequent retrieval by the National Environmental Satellite, Data, and Information Service (NESDIS) at Wallups Island, Virginia. NESDIS then rebroadcasts all data over a single high-speed channel on a Domestic Communications Satellite (DOMSAT). The Water Management Section receives DCP data from NESDIS or directly from the DCP's with a DOMSAT receive station. Maintenance of the DCP's is performed by the USGS under contract with the Corps of Engineers. In 2001, the District supported 135 permanent DCP's. A breakdown of the total number of DCP's, by states, shows 51 units in Missouri, 59 in Kansas, 18 in Nebraska, and 7 in Iowa. The District also contracted with USGS to install four temporary stream gages at sites along the Kansas River to monitor river conditions during the May through August period when endangered/threatened bird species were nesting. Additional temporary gages have also been installed along the Blue River to better define conveyance and hydrologic characteristics and along the Missouri River from Napoleon to Hermann to better define phase I, II, and III flow targets and channel degradation trends.

***Cooperative Hydrologic Programs.***

Constraints on funds and manpower do not allow the Corps to administer an independent data collection program that satisfies all of its needs. Therefore, assistance is sought from other cooperating agencies. A nationwide program of data collection at selected stream gauging stations has been administered for a number of years by the U.S. Geological Survey (USGS). A similar network of reporting stations has been operated by the National Weather Service (NWS) for their river forecasting services. Arrangements have also been made with the USGS through which they supplement their network of reporting stations, or increase the frequency of reports, to better satisfy Corps needs. A similar program had been maintained with the NWS for a number of years, but due to budget constraints it was terminated at the end of FY 2001. The program, designated the "Cooperative Hydrologic Reporting Network," is administered by the USGS and supported by funds transferred from the Corps. Arrangements for the services provided are made with USGS representatives in each state and submitted annually to the Chief of Engineers, through the Division Commander, for review and approval. The District also funds a small number of its own local stream gauge observers to satisfy the needs of individual projects. These include four locations with paid observers and an additional seven locations with unpaid observers. A summary of funds expended for data collection purposes during the report period is included in the Personnel and Funding section at the end of this report.

***Water Quality Investigations and Monitoring Activities.***

The Water Quality Unit's 2001 activities were highlighted by the continuation of long-term studies of the Big Bull (Hillsdale Lake), Chariton (Rathbun Lake), and Little Platte (Smithville Lake) watersheds. The Big Bull watershed studies with EPA 319 funding involve

numerous Federal, state, county, and local agencies, as well as citizen groups, in quantifying the levels of nutrients and herbicides throughout the watershed and implementing pollution reduction strategies. The latter include increased use of best management practices on agricultural lands and the use of constructed wetlands to improve the quality of point-source effluents. The Water Quality Unit staff teamed with Hillsdale Lake project personnel to perform the lake-monitoring portion of the work, which included monthly insitu profiling of temperature, dissolved oxygen, conductivity, pH, and redox; secchi and photic zone measurements; sample collection and filtration; chlorophyll, turbidity, immunoassay herbicide, and suspended solids analyses; coordination with other laboratories; and data management.

In the fifth year of the multi-agency, cooperative study of the Chariton watershed, the Water Quality Unit staff and Rathbun Lake project personnel teamed to perform monthly surveys of four lake stations and the outlet. Sampling of 14 tributaries was carried out by Iowa State University Limnology Laboratory personnel. The Water Quality Unit performed chlorophyll, turbidity, suspended solids, and immunoassay herbicide analyses while the Chemical and Materials Quality Assurance Laboratory (CMQAL) performed nitrogen and phosphorous group, total and dissolved iron and manganese, total and dissolved organic carbon, and pesticide analyses. The Water Quality Unit continued to provide data management for the long-term study. As in the Big Bull watershed studies, the Natural Resources Conservation Service (NRCS) with major support from 319 funding assisted in obtaining the voluntary support of the agricultural community in reducing the amount of non-point source runoff.

For its part in the Little Platte watershed studies, the Water Quality Unit staff teamed with Smithville Lake project personnel to perform monthly surveys of the three lake stations, the outlet, and the major tributary in 2001. The Water Quality Unit and CMQAL performed physical, chemical, and biological analyses noted above. Reports were provided to various members of the study and to the general public.

The Water Quality Unit staff conducted a survey of Harry S. Truman Reservoir in 2001.

The following lake projects also supported the Kansas City District water quality monitoring effort in 2001: Long Branch, Clinton, Perry, Milford, Tuttle Creek, Wilson, Kanopolis, Pomona, Melvern, and Harlan County. Approximately 140 samples per month were collected by project personnel at lake, outlet, and inflow stations and analyzed by the Water Quality Unit staff and CMQAL for herbicides and nutrients, respectively. Also, the Water Quality Unit provided equipment, training, and technical support to the cooperating projects. Reports were provided to each of the participating projects and placed on the Internet for access by other agencies and the public.

Other Water Quality Unit activities supporting the sampling and analytical activities were data management, procurement of supplies and equipment, maintenance and calibration of field and laboratory equipment, and maintenance of mobile laboratory and marine equipment. The unit also carried out a quality assurance/quality control (QA/QC) program with the cooperating laboratories. To further its capabilities, the Water Quality Unit staff completed training in Dasler, a new water quality data management program, which will have the capability of transferring data into the EPA NEW STORET database for public access on the Internet.

***Sediment Observations.***

During the Fiscal Year 2001 reporting period, the Kansas City District survey crews surveyed cross sections at stream channel degradation ranges downstream of Kanopolis, Pomona, and Pomme de Terre Dams as part of a regular cycle of monitoring. Kanopolis Dam is located in central Kansas, Pomona Dam is located in eastern Kansas, and Pomme de Terre Dam is located in central Missouri. The cross sections were plotted and compared to previous surveys.

At Kanopolis, the last partial survey was accomplished in 1971, and the last complete survey was in 1951. For this survey, the District crews conducted a reconnaissance and inventory of all 17 of the ranges. They then surveyed six of the degradation ranges. The surveys showed that there has been 3 to 5 feet of degradation since 1951, mostly closer to the dam.

At Pomona, the ranges were last surveyed in 1962 and 1975. For this iteration, 5 of the 6 ranges were relocated, surveyed, and compared to the previous surveys. Range 1 shows very little degradation of the channel, but there has been 25 to 30 feet of bank erosion on the left bank since 1962. Range 2 was reset in 1975, and the survey showed that there has been less than 1 foot of degradation since then. At range 4, there has been 4 feet of sedimentation since 1962. Range 5 shows very little change in the channel or along the banks. At range 6, there has been approximately 3 to 4 feet of sedimentation in the channel.

At Pomme de Terre, the ranges were last surveyed in 1960 and 1974. For this iteration, 5 of the 8 ranges were relocated, surveyed, and compared to the previous surveys. Ranges 1,3 and 4 show less than 1 foot of degradation. At range 6, there has been approximately 2 feet of degradation since 1960. Ranges 7 and 8 show from 3 to 5 feet of sedimentation since 1960.

Through an interagency cooperative agreement with the USGS, the District collects point, depth integrated, and bed sample sediment samples at three Missouri River stations and two inflow stations to Harry S. Truman Reservoir. The Missouri River data at St. Joseph, Kansas City, and Hermann include point velocities. Laboratory analyses are performed at the USGS facility at Rolla, Missouri, and the results are stored in their database. The USGS publishes the suspended sediment load data for the Schell City and Clinton stations.

The District hydrographic survey crews conducted reservoir surveys at Perry Lake in Kansas and Long Branch Lake in Missouri. At Perry Lake, the soundings were completed in April and May 2001. The land portion of the surveys is programmed for 2002. At Long Branch Lake, both the soundings and land portions were completed in August and September 2001. After digital terrain models of each lake are completed, new elevation-area-capacity tables will be developed.

In February and March 2001, the District hydrographic survey crews completed 218 cross sections at the Lake of the Ozarks from Warsaw to Bagnell Dam. A digital terrain model of the project was completed. The data will be used by the Federal Emergency Management Agency for a flood insurance study. In June 2001, District crews set high water marks along Stranger Creek in Kansas and the Blue River in Kansas City after major flooding events. In July 2001, the survey crew surveyed 10 cross sections along Missouri River Levee L-476 as part of a maintenance project.

**RESEARCH AND STUDIES.**

Until FY 2002, Water Management Section staff were included on a Kansas City District team for the Upper Mississippi River Basin Flow Frequency Study, a cooperative study with four other districts, other Federal agencies, and public and academic interests. During this reporting period, Kansas City District completed most of its work on the observed, unregulated and current level daily flow analysis for the lower Missouri River tributaries. Omaha District incorporated the Kansas City District analysis into their main stem models to combine the upper Missouri River data with the lower basin data and produce data sets for use by Saint Louis District in their Mississippi River analysis. A hydrology report is now being reviewed, and new peak discharge frequencies will soon be released. Other Kansas City District personnel are working on the mapping effort along the main stem of the Missouri River and updating the Missouri River UNET model.

As part of a continual process, the Corps Dam Safety Assurance Program reviews the safety of existing dams and considers new data or state-of-the-art design and construction methods for severe earthquake and extreme flood design. Tuttle Creek Dam is in a region that has experienced moderate to large earthquakes. Evaluations of Tuttle Creek Dam that have included worldwide experts, using state-of-the-art techniques, show that the dam is at risk of significant damage by a moderate earthquake to the point that an uncontrolled release of the lake is possible. Although the probability of an earthquake of the size necessary to damage the dam is very small, due to the potential consequences this possibility is being taken with all seriousness.

At the same time, evaluations using state-of-the art computer models were performed on Tuttle Creek Dam under what is believed to be the worst possible storm that could ever occur in the area, the spillway design flood. These evaluations show that the floodwaters captured by the dam would cause a slightly higher lake level than originally anticipated. The revised flood modeling assumes that approximately 24 inches of rain falls within the drainage basin when the lake is already full due to previous storms. The runoff would fill the lake to near the top of the dam and result in a flow through the spillway that would be 10 times greater than during the 1993 flood. Calculations show that when the lake is at its maximum elevation wind driven waves could splash over the top of the dam. Another entirely separate evaluation also shows that the spillway gate arms may not be strong enough to withstand the stresses of opening the gates when the lake level is near the top of the gates.

The necessary repairs to address wave protection and strengthening of the gates are relatively simple compared to the earthquake concerns, and the structural repairs will be incorporated into any plan to address the earthquake issues. The spillway gates can be strengthened to meet current design criteria, and concrete highway divider barriers can be added to the top of the dam to provide wave protection.

A range of alternatives from minimizing risk to a total replacement of the dam is being considered to address the earthquake concerns at Tuttle Creek Dam. Minimizing risks can include variations on improved emergency planning, better downstream flood plain management, or lowering normal lake levels. Structural improvements to the dam can include improved seepage control, stabilizing the soil under the dam, and enlarging the dam. The studies have determined that the design of the intake tower and outlet works is adequate under current standards.

The identified problems, the potential alternatives, and the schedule to address the concerns are discussed in more detail on the District web site at
http://www.nwk.usace.army.mil/tcdam
An Initial Evaluation Report dated July 1996 identified the potential problems and justified the need to proceed with detailed studies. Those studies were begun immediately afterward. Meetings with government agencies and affected communities were held during the March through May 2001 period to review the initial results of the detailed studies. A draft evaluation report and environmental impact statement will be issued for public review in the March to May 2002 period, after which the evaluation report and EIS will be finalized. A Record Of Decision is expected to be signed by October 2002, after which implementation of the selected plan to address the earthquake risks will begin. If an alternative is selected that requires modification of the dam, further investigations and the design of any repairs would extend over about two years, and actual full-scale construction work could be initiated during the fall of 2004.

Work on the earthquake concerns at Tuttle Creek Dam will proceed independently of a proposal by a private company, Symbiotics LLC, to install a small hydroelectric generator in the dam. In April, 2001, Symbiotics filed a Preliminary Permit Application with the Federal Energy Regulatory Commission to conduct environmental reviews and preliminary design work over the next three years. The application may be viewed at the web link
http://rimsweb1.ferc.fed.us/rims.q?rp2~intro
The Corps does not have any statutory role in the development or submission of this application, but the Corps has requested that it be consulted regarding the proposed studies. Similar permit applications were filed for Milford, Glen Elder, Pomme de Terre, Stockton, and Perry Lakes.

## TRAINING AND METHODS.

Training of Water Management Section staff progresses as time and scheduling permit. Technical abilities are enhanced as individuals continue to pursue courses on their own initiative. During the period of this report, Section employees participated in the training courses listed in Table 4. In addition, all staff members attended in-house training on ISO Business Procedures, Business and Quality Processes, Defensive Driving, Information Security, and Prevention of Sexual Harassment.

**Table 4: Staff Training**

| Employee | Course or Training |
|---|---|
| Alan Bruns | Riverware: Intro to Rule-Based Sim |
| Jan Doughman | Civil Works Orientation<br>CWMS Orientation |
| Paul Hansen | System Administration Security<br>Network Management Security |
| Debbie Noble | Hydrologic Engineering for Planning |
| Edward Parker | Riverware: Intro to Rule-Based Sim |
| Steve Spaulding | Riverware: Intro to Rule-Based Sim |

## PERSONNEL AND FUNDING.

### *Personnel.*

Authorized positions of the Water Management Section at the close of this reporting period (July 31, 2001) consisted of one Supervisory Hydraulic Engineer, four Hydraulic Engineers, one Hydrologist, and three Hydrologic Technicians. At the end of this reporting period, the Section was fully staffed. A listing of the personnel currently employed in the Section by name and title is shown in Table 5.

**Table 5: Water Management Section Personnel**

| Employee | Grade |
|---|---|
| Richard Oldham (1) | GS-13 |
| Alan Bruns (3) | GS-12 |
| Jan Doughman (4) | GS-10 |
| Paul Hansen (2) | GS-12 |
| Jerry Holtz (4) | GS-10 |
| Jim Knapp (2) | GS-12 |
| Debbie Noble (4) | GS-09 |
| Edward Parker (2) | GS-12 |
| Steve Spaulding (2) | GS-12 |

**Job Title**
(1) Supervisory Hydraulic Engineer
(2) Hydraulic Engineer
(3) Hydrologist
(4) Hydrologic Technician

### *Funding.*

Activities of the Water Management Section are funded from the following sources:

Planning.

Part of the funds appropriated for survey reports, flood plain information studies, and project planning studies are assigned to the Water Management Section for special studies if water control plans or associated studies are included in connection with the planning and design of projects in the Kansas City District.

Operations and Maintenance.

Operation of the existing lakes and reservoirs in the Kansas City District requires stream flow forecasting, water control planning, stream gauging, and other related activities for each authorized function at Corps of Engineers projects, and for the flood control function at Bureau of Reclamation projects. Operation and maintenance funds are used for these purposes.

Technical Services and Flood Emergency.

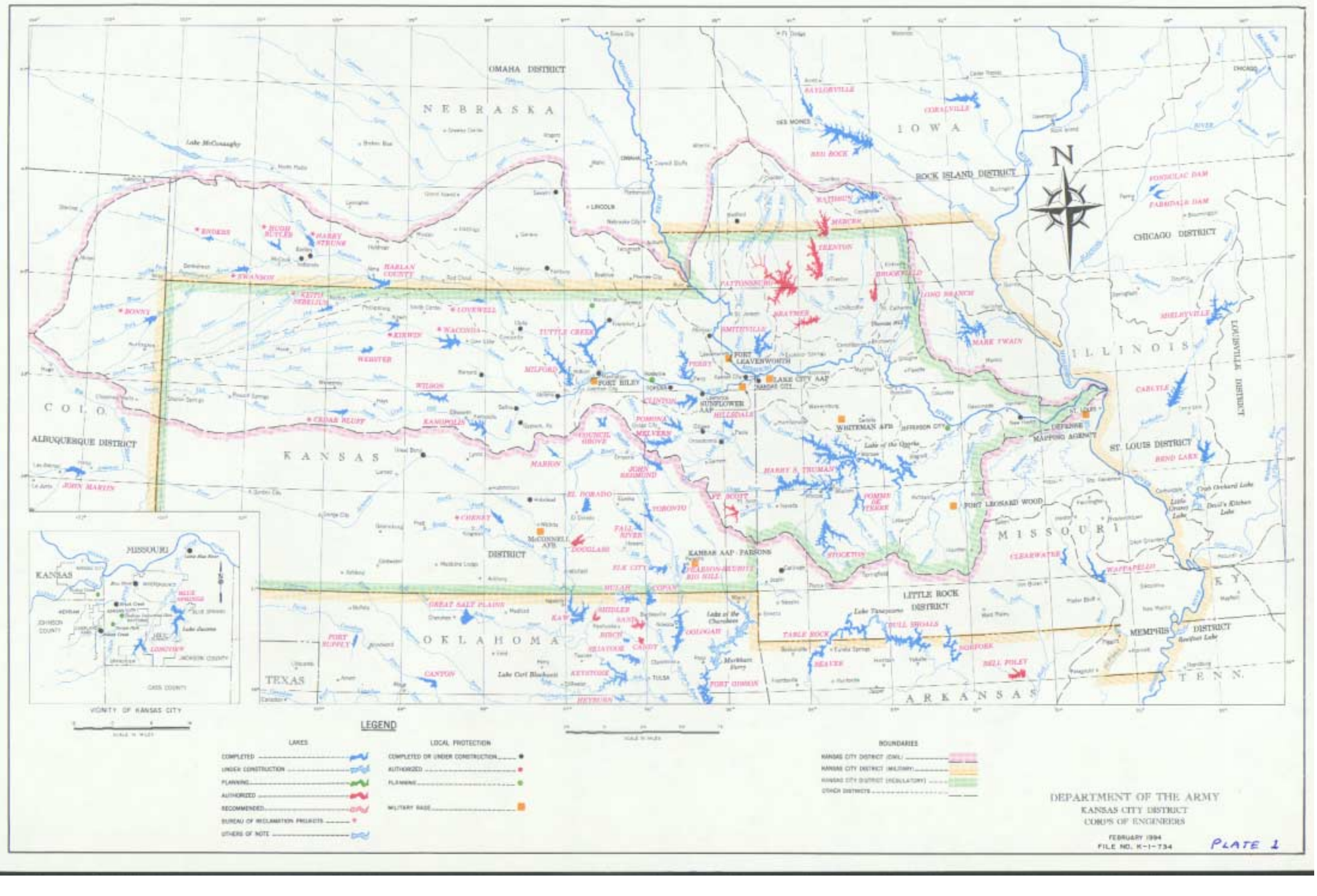
Technical services provided to non-Federal interests, flood emergency operations, post flood reports, and the annual flood report are tasks assigned to the Water Management Section. These activities vary from year to year. Special accounts are provided for these services.

Data Collection Programs.

In Fiscal Year 2001, the National Weather Service provided data from 64 precipitation stations through the Cooperative Reporting Network (FC-33 Program). Funds for FY 2001 were transferred from the Kansas City District to the National Weather Service. In FY 2002, rainfall reporting from the lake projects and automated precipitation measuring equipment at stream gage sites reported in real time is replacing the manual reporting system used by the National Weather Service. There are no additional costs associated with the FY 2002 program.

The Cooperative Stream Gauging Program with the four U.S. Geological Survey districts (Kansas, Nebraska, Iowa, and Missouri) includes 135 stations. Kansas City District funding for this program during FY 2002 increase slightly from the FY 2001 program.

Stage data were obtained by the Kansas City District during the period of this report from 11 independent stations, either under contract or where supplies are issued for the purpose of data collection. Four of the locations have paid observers, and seven locations have unpaid observers in cooperating agencies.




DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

FEBRUARY 1994
FILE NO. K-1-734

PLATE 1

| SUBJECT | MELVERN LAKE | POMONA LAKE | HILLSDALE LAKE | STOCKTON LAKE | POMME DE TERRE LAKE | HARRY S. TRUMAN RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Melvern, KS | Near Pomona, KS | Near Paola, KS | Near Stockton, MO | Near Hermitage MO | Near Warsaw, MO | (2) Damming height is from the original riverbed to the top of the flood control pool. |
| Stream / River | Marais des Cygnes River | 110 Mile Creek | Big Bull Creek | Sac River | Pomme de Terre River | Osage River | (3) Based on latest available storage data. The revision dates of the current area - capacity tables are indicated below with the effective dates in parentheses: |
| Miles above Mouth | 175.4 | 8.3 | 18.2 | 51.4 | 45.6 | 175.1 | Melvern, February 1986 (effective March 1, 1986) |
| Contributing Drainage Area, square miles | 349 | 322 | 144 | 1,160 | 611 | 8,914 (4) | Pomona, March 1990 (effective April 1, 1990) |
| Approximate Length of Full Reservoir, miles | 22 | 12 | 15 | 24 | 28 | 122 | Hillsdale, 1969 (initial) |
| Shoreline, miles (1) | 101 | 52 | 51 | 298 | 113 | 958 | Stockton, February 1988 (effective May 1, 1988) |
| Maximum Discharge of Record nr Dam Site | 68,500 cfs (July 11, 1951) | 38,600 cfs (July 11, 1951) | 45,200 cfs (July 11, 1951) | 120,000 cfs (May 19, 1943) | 70,000 cfs (August 8, 1927) | 259,000 cfs (May 17, 1943) | Pomme de Terre, February 1985 (effective Mar 85) |
| Date of Closure | October 2, 1970 | July 19, 1962 | June 15, 1980 | September 23, 1968 | June 28, 1960 | July 21, 1977 | Harry S. Truman, April 1993 (effective Mar 94) |
| Date Storage Began | August 1, 1972 | October 18, 1963 | September 19, 1981 | December 12, 1969 | October 29, 1961 | February 7, 1979 | (4) The total drainage area above Truman Reservoir is 11,500 square miles. The indicated total is the local drainage area below the upstream dams. |
| Date Multipurpose Level Reached | April 4, 1975 | June 5, 1965 | February 23, 1985 | December 18, 1971 | June 15, 1963 | November 29, 1979 | |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | | | | |
| Top of Dam Elevation, feet msl | 1,078 | 1,031 | 952.2 | 911 | 906 | 756 | |
| Length of Dam, feet (net) | 9,650 | 7,750 | 8,700 plus 3,300 dike | 5,100 plus 5,600 dike | 4,630 plus 2,790 dike | 5,000 plus 7,500 dike | |
| Damming Height, feet (2) | 105 | 83 | 79 | 132 | 124 | 105 | |
| Type of Fill | Earth | Earth | Earth | Rock Shell | Earth | Earth | |
| Fill Quantity, cubic yards | 9,100,000 | 5,200,000 | 6,964,000 | 7,100,000 | 5,800,000 | 8,500,000 | |
| **SPILLWAY** | | | | | | | |
| Location | Left Abutment | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Center of Dam | |
| Crest Elevation, feet msl | 1,057 | 1,006 | 935 | 861.5 | 874 | 692.3 | |
| Width, Feet | 200 | 200 | 50 | 160 | 170 | 160 | |
| Number, Size, and Type of Gates | None | None | None | 4 - 40’x30.5’ Tainter | None | 4 - 40’x47.3’ Tainter | |
| Discharge Capacity, Top of Surcharge Pool | 36,000 cfs | 50,300 cfs | 4,750 cfs | 182,500 cfs | 73,000 cfs | 284,000 cfs | |
| **RESERVOIR (3)** | | | | | | | **TOTALS** |
| Surcharge Pool Elevation and Area | 1,073.0 ft msl 22,673 ac | 1,025.4 ft msl 14,584 ac | 948.0 ft msl 10,983 ac | 906.2 ft msl 48,053 ac | 900.2 ft msl 25,456 ac | 751.1 ft msl 295,870 ac | 417,619 ac |
| Flood Control Pool Elevation and Area | 1,057.0 ft msl 13,935 ac | 1,003.0 ft msl 8,522 ac | 931.0 ft msl 7,413 ac | 892.0 ft msl 38,281 ac | 874.0 ft msl 15,999 ac | 739.6 ft msl 209,048 ac | 293,198 ac |
| Multipurpose Pool Elevation and Area | 1,036.0 ft msl 6,912 ac | 974.0 ft msl 3,865 ac | 917.0 ft msl 4,575 ac | 867.0 ft msl 24,632 ac | 839.0 ft msl 7,790 ac | 706.0 ft msl 55,406 ac | 103,180 ac |
| Surcharge Storage, AF | 1,073.0 - 1,057.0 289,410 | 1,025.4 - 1,003.0 255,327 | 948.0 - 931.0 155,799 | 906.2 - 892.0 608,708 | 900.2 - 874.0 535,724 | 751.1 - 739.6 2,910,768 | 4,755,736 AF |
| Flood Control Storage, AF | 1,057.0 - 1,036.0 208,207 | 1,003.0 - 974.0 176,123 | 931.0 - 917.0 83,570 | 892.0 - 867.0 776,066 | 874.0 - 839.0 406,821 | 739.6 - 706.0 4,006,415 | 5,657,202 AF |
| Multipurpose Storage, AF | 1,036.0 - 965.0 152,051 | 974.0 - 930.0 64,208 | 917.0 - 852.5 76,270 | 867.0 - 765.0 874,887 | 839.0 - 750.0 237,356 | 706.0 - 631.0 1,180,617 | 2,585,389 AF |
| Gross Storage, AF | 1,057.0 - 965.0 360,258 | 1,003.0 - 930.0 240,331 | 931.0 - 852.5 159,840 | 892.0 - 765.0 1,650,953 | 874.0 - 750.0 644,177 | 739.6 - 631.0 5,187,032 | 8,242,591 AF |
| Design Sediment Reserve Storage | 26,000 AF for 100 years | 28,000 AF for 100 years | 11,000 AF for 100 years | 25,000 AF for 100 years | 13,000 AF for 50 years | 244,000 AF for 100 years | |
| Measured Sediment Inflow | 4,064 AF (1972 to 1985) | 7,045 AF (1963 to 1989) | 1,928 AF (1981 to 1993) | 8,953 AF (1969 to 1987) | 4,358 AF (1961 to 1974) | 22,321 AF (1979 to 1992) | |
| **OUTLET WORKS** | | | | | | | |
| Location | Right Abutment | Right Abutment | Left Abutment | | Right Abutment | | ac = acres |
| River Outlet Type | Gated Horseshoe Conduit | Gated Horseshoe Conduit | Gated Oblong Conduit | None | Gated Tunnel | None | AF = acre-feet |
| Number and Size of Conduit | 1 - 11.5’ | 1 - 13.5’ | 1 - 15.92’x11.67’ | | 1 - 14’ | | ft = feet |
| Length of Conduit, feet | 754 | 720.5 | 685 | | 560 | | msl = elevation above mean sea level |
| Entrance Invert Elevation | 962 ft msl | 925 ft msl | 868 ft msl | | 750 ft msl | | cfs = cubic feet per second |
| Discharge Capacity, Top of Surcharge Pool | 6,700 cfs | 9,200 cfs | 8,200 cfs | | 12,750 cfs | | kw = kilowatts |
| Discharge Cap, Top of Flood Control Pool | 6,235 cfs | 8,170 cfs | 7,400 cfs | | 11,500 cfs | | hp = horsepower |
| Discharge Cap, Top of Multipurpose Pool | 5,520 cfs | 6,400 cfs | 6,150 cfs | | 9,650 cfs | | |
| Service Gates, Number and Size | 2 - 6’x12’ | 2 - 6.5’x14’ | 2 - 5.33’x15.92’ | | 2 - 6.5’x14’ | | |
| Emergency Gates, Number and Size | 2 - 6’x12’ | 2 - 6.5’x14’ | 1 - 5.33’x15.92’ | | 1 - 6.5’x14’ | | |
| Low Flow Gates, Number and Size | 2 - 2’x2’ | 2 - 2’x2’ | 2 - 2’x2’ | 2 - 24” dia | 1 - 24” Butterfly | | |
| Provision for Power | None | None | None | 3 - 20’x40’ | | 12 - 17’x26.5’ | |
| **POWER FACILITIES** | | | | | | | |
| Generator Turbine Units, Number | | | | 1 | | 6 | |
| Generator Name Plate Capacity, kw | | | | 45,200 | | 160,000 | |
| Turbine Rating, hp | | | | 75,600 (56 ft head) | | 254,400 | |
| Turbine Type | | | | Kaplan (Vertical Shaft) | | Kaplan (Inclined Shaft) | |
| Maximum (Full Pool) Head and Discharge | | | | 112 ft (6,300 cfs) | | 79.2 ft (31,800 cfs) | |
| Avg (Power & MP Pool) Head and Discharge | | | | 85 ft (7,900 cfs) | | 42.5 ft (65,000 cfs) | |
| Minimum Head and Discharge | | | | 62 ft (11,000 cfs) | | 41 ft (68,000 cfs) | |
| Reversible Pump Turbines | | | | None | | 6 | |
| Total Dynamic Head, feet | | | | | | 50 | |
| Discharge with 5 Units at Max Head, cfs | | | | | | 27,500 | |
| Maximum Power Required, hp | | | | | | 197,000 | |
| Maximum Drawdown, feet msl | | | | 845 | | 704 | |

**SUMMARY OF ENGINEERING DATA**
**OSAGE RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2001

Plate 2A

| SUBJECT | SMITHVILLE LAKE | LONGVIEW LAKE | BLUE SPRINGS LAKE | RATHBUN LAKE | LONG BRANCH LAKE | REMARKS |
|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Smithville, MO | Kansas City, MO | Kansas City, MO | Near Rathbun, IA | Near Macon, MO | (2) Damming height is from original riverbed to top of flood pool. |
| Stream / River | Little Platte River | Little Blue River | East Fork Little Blue River | Chariton River | East Fork Little Chariton River | (3) Based on latest available storage data. The revision dates of the current area capacity tables are indicated below with the effective dates in parentheses: |
| Miles above Mouth | 13.6 | 42.9 | 28.8 | 142.3 | 78 | Smithville Lake, February 1990 (effective March 1, 1990) |
| Contributing Drainage Area, square miles | 213 | 50.3 | 32.8 | 549 | 109 | Longview Lake, May 1970 (initial) |
| Approximate Length of Full Reservoir, miles | 18 | 3.5 | 2.5 | 14 | 9 | Blue Springs Lake, September 1974 (initial) |
| Shoreline, miles (1) | 175 | 24 | 12 | 155 | 24.2 | Rathbun Lake, January 2000 (effective December 1, 2000) |
| Maximum Discharge of Record near Dam Site | 76,600 cfs (July 20, 1965) | 18,700 cfs (August 13, 1982) | 11,000 cfs (August 13, 1982) | 21,800 cfs (March 31, 1960) | 30,000 cfs (April 21, 1973) | Long Branch Lake, January 1989 (effective July 1, 1989) |
| Date of Closure | July 13, 1976 | June 16, 1983 | August 12, 1986 | September 29, 1967 | September 3, 1976 | (4) Spillway flood routing at Long Branch Lake revised for Emergency Action Plan, dated 1981. |
| Date Storage Began | October 19, 1979 | September 16, 1985 | September 27, 1988 | November 21, 1969 | August 2, 1978 | (5) The Rathbun outlet works cannot discharge more than 1,800 cfs without special approval from the Water Mgmt office. Flows above 1,800 cfs result in overtopping of the outlet works stilling basin walls. |
| Date Multipurpose Level Reached | June 11, 1982 | September 23, 1986 | March 18, 1990 | October 10, 1970 | May 19, 1981 | |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | | | |
| Top of Dam Elevation, feet msl | 895 | 926.6 | 840 | 946 | 826 | |
| Length of Dam, feet (net) | 4,000 | 1,900 | 2,500 | 10,600 | 3,550 | |
| Damming Height, feet (2) | 80.2 | 110 | 70 | 82 | 71 | |
| Type of Fill | Rolled Earth | Earth | Earth and Rock | Rolled Earth | Rolled Earth | |
| Fill Quantity, cubic yards | 3,200,000 | 2,500,000 | 1,200,000 | 4,700,000 | 1,855,000 | |
| **SPILLWAY** | | | | | | |
| Location | Right Abutment | Left Abutment | Left Abutment | Right Abutment | Right Abutment | |
| Crest Elevation, feet msl | 880.2 | 911.3 | 823.6 | 926 | 809 | |
| Width, feet | 50 | 200 | 300 | 500 | 50 | |
| Number, Size, and Type of Gates | None | None | None | None | None | |
| Discharge Capacity, Top of Surcharge Pool | 4,800 cfs | 22,970 cfs | 37,800 cfs | 45,600 cfs | 9,860 cfs (4) | |
| **RESERVOIR (3)** | | | | | | **TOTALS** |
| Surcharge Pool Elevation and Area | 891.1 ft msl 14,611 ac | 922.9 ft msl 3,207 ac | 837.7 ft msl 1,200 ac | 940.0 ft msl 31,135 ac | 821.2 ft msl 6,608 ac (4) | 56,761 ac |
| Flood Control Pool Elevation and Area | 876.2 ft msl 9,990 ac | 909.0 ft msl 1,964 ac | 820.3 ft msl 982 ac | 926.0 ft msl 22,452 ac | 801.0 ft msl 3,663 ac | 39,051 ac |
| Multipurpose Pool Elevation and Area | 864.2 ft msl 7,115 ac | 891.0 ft msl 927 ac | 802.0 ft msl 722 ac | 904.0 ft msl 10,329 ac | 791.0 ft msl 2,429 ac | 21,522 ac |
| Recreation Pool Elevation and Area | | 870.0 ft msl 432 ac | | | | 432 ac |
| Surcharge Storage | 891.1 - 876.2 182,198 AF | 922.9 - 909.0 35,370 AF | 837.7 - 820.3 19,039 AF | 940.0 - 926.0 368,859 AF | 821.2 - 801.0 101,880 AF (4) | 707,346 AF |
| Flood Control Storage | 876.2 - 864.2 101,777 AF | 909.0 - 891.0 24,810 AF | 820.3 - 802.0 15,715 AF | 926.0 - 904.0 349,173 AF | 801.0 - 791.0 30,327 AF | 521,802 AF |
| Multipurpose Storage | 864.2 - 810.0 141,666 AF | 891.0 - 870.0 13,579 AF | 802.0 - 760.0 10,842 AF | 904.0 - 857.0 221,360 AF | 791.0 - 750.0 34,189 AF | 421,636 AF |
| Recreation Storage | | 870.0 - 810.0 8,555 AF | | | | 8,555 AF |
| Gross Storage | 876.2 - 810.0 243,443 AF | 909.0 - 810.0 46,944 AF | 820.3 - 760.0 26,557 AF | 926.0 - 857.0 570,533 AF | 801.0 - 750.0 64,516 AF | 951,993 AF |
| Design Sediment Reserve Storage | 52,300 AF for 100 years | 2,000 AF for 100 years | 300 AF for 100 years | 24,000 AF for 100 years | 4,000 AF for 100 years | |
| Measured Sediment Inflow | 4,987 AF (1979 to 1993) | 20 AF/year (estimated) | 3 AF/year (estimated) | 240 AF/year (estimated) | 483 AF (1978 to 1988) | |
| **OUTLET WORKS** | | | | | | |
| Location | Right Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | |
| River Outlet Type | Rectangular Conduit | Concrete Arch | Arch Conduit | Horseshoe Conduit | Concrete Arch | ac = acres |
| Number and Size of Conduit | 1 - 8'x9' | 1 - 5.5'x5' | 1 - 3.5'x4.75' | 1 - 11' | 1 - 6'x5.5' | AF = acre-feet |
| Length of Conduit, feet | 696 | 916 | 485 | 539 | 450 | ft = feet |
| Entrance Invert Elevation | 805 ft msl | 816 ft msl | 768.5 ft msl | 855 ft msl | 760 ft msl | msl = elevation above mean sea level |
| Drop Inlet Crest Elevation | | 891 | 802.0 ft msl | | | cfs = cubic feet per second |
| Low Flow Gate Intake Elevation | | 875 - 861 | 791.5 | | | |
| Discharge Cap, Top Flood Control Pool | 3,150 cfs | 1,200 cfs | 570 cfs | 5,160 cfs (5) | 910 cfs | |
| Discharge Cap, Top of Multipurpose Pool | 2,940 cfs | 0 (except low flow outlets) | 0 (except low flow outlets) | 4,220 cfs (5) | 495 cfs | |
| Service Gates, Number and Size | 2 - 4.25'x9.25' Slide | | | 2 - 6'x12' Slide | 2 - 24" Slide | |
| Emergency Gates, Number and Size | 2 - 4.25'x9.25' Slide | 1 - 6'x7' | 1-4.5'x5' | 2 - 6'x12' Slide | 1 - 6'x6' | |
| Low Flow Gates, Number, Size, Type | | 2 - 24" Knife Valves | 1-2' Knife Valve | | | |
| Low Flow Gates, Number and Size | 1 - 2'x2' | 2 - 24" Knife Valves | 1-2' Knife Valve | 2 - 2' x2' Slide | 1 - 18" Slide | |
| Provision for Water Supply | 1 - 5.75' Pipe | | | | | |
| Provision for Power | None | None | None | None | None | |

**SUMMARY OF ENGINEERING DATA**
**LOWER MISSOURI RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City Distict
December 2001

Plate 2B

| SUBJECT | MILFORD LAKE | TUTTLE CREEK LAKE | PERRY LAKE | CLINTON LAKE | REMARKS |
|---|---|---|---|---|---|
| **GENERAL** | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Junction City, KS | Near Manhatten, KS | Near Perry, KS | Near Lawrence, KS | (2) Damming height is from the original riverbed to the top of the flood control pool. |
| Stream / River | Republican River | Big Blue River | Delaware River | Wakanusa River | (3) Based on latest available storage data. The revision dates of the current |
| Miles above Mouth | 7.7 | 10 | 5.3 | 22.2 | area - capacity tables are indicated below with the effective dates in parentheses: |
| Contributing Drainage Area, square miles | 17,388 (4) | 9,628 | 1,117 | 367 | Milford Lake, March 1982 (effective March 10, 1982) |
| Approximate Length of Full Reservoir, miles | 30 | 50 | 20 | 17 | Tuttle Creek Lake, October 2000 (effective February 1, 2001) |
| Shoreline, miles (1) | 163 | 112 | 160 | 82 | Perry Lake, May 1990 (effective June 1, 1990) |
| Maximum Discharge of Record near Dam Site | 171,000 cfs (June 3, 1935) | 98,000 cfs (June 1951) | 94,600 cfs (June 1951) | 24,200 cfs (July 1951) | Clinton Lake, December 1991 (effective March 1, 1994) |
| Date of Closure | August 24, 1964 | July 20, 1959 | August 2, 1966 | August 23, 1975 | (4) Total drainage area above Milford is 38,621 square miles. The indicated total is |
| Date Storage Began | January 16, 1967 | March 7, 1962 | January 15, 1969 | November 30, 1977 | the local drainage area below Harlan County Dam. |
| Date Multipurpose Level Reached | July 14, 1967 | April 29, 1963 | June 3, 1970 | April 3, 1980 | |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | | ac = acres |
| Top of Dam Elevation, feet msl | 1,213 | 1,159 | 946 | 928 | AF = acre-feet |
| Length of Dam, feet (net) | 6,300 | 7,487 | 7,750 | 9,250 | ft = feet |
| Damming Height, feet (2) | 110.2 | 134 | 95 | 114 | msl = elevation above mean sea level |
| Type of Fill | Earth | Earth, Rock | Earth | Earth | cfs = cubic feet per second |
| Fill Quantity, cubic yards | 15,000,000 | 21,000,000 | 8,000,000 | 10,423,000 | |
| **SPILLWAY** | | | | | |
| Location | Right Abutment | Left Abutment | Left Abutment | Left Abutment | |
| Crest Elevation, feet msl | 1,176.2 | 1,116 | 922 | 907.4 | |
| Width, feet | 1,250 | 1,059 | 300 | 500 | |
| Number, Size, and Type of Gates | None | 18 - 40'x20' Tainter | None | None | |
| Discharge Capacity, Top of Surcharge Pool | 560,000 cfs | 579,000 cfs | 65,000 cfs | 44,200 cfs | |
| **RESERVOIR (3)** | | | | | **TOTALS** |
| Surcharge Pool Elevation and Area | 1,208.2 ft msl 59,886 ac | 1,151.4 ft msl 70,030 ac | 941.2 ft msl 42,656 ac | 921.4 ft msl 18,336 ac | 190,908 ac |
| Flood Control Pool Elevation and Area | 1,176.2 ft msl 32,979 ac | 1,136.0 ft msl 53,050 ac | 920.6 ft msl 25,363 ac | 903.4 ft msl 12,890 ac | 124,282 ac |
| Multipurpose Pool Elevation and Area | 1,144.4 ft msl 15,709 ac | 1,075.0 ft msl 12,617 ac | 891.5 ft msl 11,146 ac | 875.5 ft msl 7,120 ac | 46,592 ac |
| Surcharge Storage | 1,208.2 - 1,176.2 1,442,049 AF | 1,151.4 - 1,136.0 939,272 AF | 941.2 - 920.6 692,375 AF | 921.4 - 903.4 285,809 AF | 3,359,505 AF |
| Flood Control Storage | 1,176.2 - 1,144.4 756,669 AF | 1,136.0 - 1,075.0 1,870,735 AF | 920.6 - 891.5 515,795 AF | 903.4 - 875.5 268,783 AF | 3,411,982 AF |
| Multipurpose Storage | 1,144.4 - 1,080.0 388,816 AF | 1,075.0 - 1,020.0 280,137 AF | 891.5 - 835.0 209,513 AF | 875.5 - 828.0 125,334 AF | 1,003,800 AF |
| Gross Storage | 1,176.2 - 1,080.0 1,145,485 AF | 1,136.0 - 1,020.0 2,150,872 AF | 920.6 - 835.0 725,308 AF | 903.4 - 828.0 394,117 AF | 4,415,782 AF |
| Design Sediment Reserve Storage | 160,000 AF for 100 years | 240,312 AF for 50 years | 140,000 AF for 100 years | 28,500 AF for 100 years | |
| Measured Sediment Inflow | 47,935 AF (1967 to 1994) | 216,145 AF (1962 to 2000) | 49,057 AF (1969 to 1993) | 3,421 AF (1977 to 1991) | |
| **OUTLET WORKS** | | | | | |
| Location | Right Abutment | Right Abutment | Near Center of Dam | Left Abutment | |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | |
| Number and Size of Conduit | 1 - 21' | 2 - 20' | 1 - 23.5' | 1 - 12.5'x13' Arch | |
| Length of Conduit, feet | 615.5 | 860 | 592 | 710 | |
| Entrance Invert Elevation | 1,080 ft msl | 1,003 ft msl | 833 ft msl | 828 ft msl | |
| Gated Sluice, Number and Size | None | None | None | None | |
| Discharge Cap, Top of Flood Control Pool | 23,100 cfs | 45,900 cfs | 27,500 cfs | 7,570 cfs | |
| Discharge Cap, Top of Multipurpose Pool | 18,600 cfs | 31,300 cfs | 21,200 cfs | 5,900 cfs | |
| Service Gates, Number and Size | 2 - 10.5'x21' | 4 - 10'x20' | 2 - 11.75'x23.5' | 2 - 6.33'x12.67' | |
| Emergency Gates, Number and Size | 2 - 10.5'x21' | 1 - 10'x20' | 2 - 11.75'x23.5' | 1 - 6.33'x12.67' | |
| Low Flow Gates, Number and Size | 2 - 2'x2' | 2 - 24" Butterfly Valve | 2 - 2'x2' | 1 - 24" Knife Gate Value | |
| Water Supply Gate, Number and Size | None | None | None | 1 - 54"x54" Slide Gate | |
| Provision for Irrigation | None | None | None | None | |
| Provision for Power | None | None | None | None | |
| Provision for Water Supply | None | None | None | 36" Steel Pipe | |

**SUMMARY OF ENGINEERING DATA**
**LOWER KANSAS RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2001

Plate 2C

| SUBJECT | BONNY RESERVOIR | SWANSON LAKE | ENDERS RESERVOIR | HUGH BUTLER LAKE | HARRY STRUNK LAKE | KEITH SEBELIUS LAKE (Norton Dam) | HARLAN COUNTY LAKE | LOVEWELL RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | | | (1) With pool at MP level. |
| Location of Dam | Near Hale, CO | Near Trenten, NE | Near Enders, NE | Near McCook, NE | Near Cambridge, NE | Near Norton, KS | Nr Republican City, NE | Near Lovewell, KS | (2) Damming height is |
| Stream / River | S. Fk Republican River | Republican River | Frenchman Creek | Red Willow Creek | Medicine Creek | Prairie Dog Creek | Republican River | White Rock Creek | from original riverbed to |
| Miles above Mouth | 60.4 | 359 | 81.7 | 18.7 | 11.9 | 74.9 | 232.3 | 19.3 | top of flood control pool. |
| Contributing Drainage Area, sq mi | 1,435 | 2,506 below Bonny | 786 | 310 | 642 | 688 | 7,169 below u/s dams (5) | 358 | (3) Based on latest storage |
| Approx Length of Full Resv, miles | 5.5 | 9.0 | 6.0 | 7.5 | 8.5 | 9.5 | 17 | 11 | data. Date of current area |
| Shoreline, miles (1) | 15.0 | 30 | 26 | 35 | 29 | 32 | 54 | 44 | capacity tables given below |
| Max. Disch. of Record nr Dam Site | 103,000 (May 31, 1935) | 200,000 (May 31, 1935) | Insufficient Data | 30,000 (June 22, 1947) | 120,000 (June 1947) | 37,500 (May 28, 1953) | 260,000 (June 1, 1935) | 23,300 (July 10, 1950) | with effective date in ( ). |
| Date of Closure | July 6, 1950 | May 4, 1953 | October 23, 1950 | September 5, 1961 | August 8, 1949 | January 28, 1964 | July 22, 1951 | May 29, 1957 | Bonny, Mar 51 (initial) |
| Date Storage Began | July 6, 1950 | May 4, 1953 | October 23, 1950 | September 5, 1961 | August 8, 1949 | October 5, 1964 | November 14, 1952 | October 2, 1957 | Swanson, Feb 84 (Jan 84) |
| Date Multipurpose Level Reached | March 19, 1954 | May 15, 1957 | January 29, 1952 | May 21, 1967 | April 2, 1951 | June 21, 1967 | June 14, 1957 | May 20, 1958 | Enders, May 97 (Jan 1, 99) |
| Operating Agency | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Corps of Engineers | Bureau of Reclamation | Butler, May 97 (Jan 1, 99) |
| **DAM AND EMBANKMENT** | | | | | | | | | Strunk, Oct 82 (Feb 1, 83) |
| Top of Dam Elevation, feet msl | 3,742.0 | 2,793.0 | 3,137.5 | 2,634.0 | 2,415.0 | 2,347.0 | 1,982.0 | 1,616.0 | Sebelius, Sep 00 (Jan 02) |
| Length of Dam, feet (Less Spillway) | 9,141.5 | 8,600 | 2,242 | 3,159 | 5,665 | 6,344 | 11,830 | 8,392 | Harlan, Jan 01 (Jan 1, 01) |
| Damming Height, feet (2) | 93.0 | 80.0 | 93.0 | About 85 | 86 | 85.5 | 98.5 | 70.3 | Lovewell, Jun 95 (Jan 97) |
| Type of Fill | Earth | Earth | Earth | Earth | Earth | Earth | Earth | Earth | (4) Bartley Div Dam, Rep |
| Fill Quantity, cubic yards | 8,853,000 | 8,130,000 | 1,950,000 | 3,122,000 | 2,730,000 | 3,740,000 | 13,400,000 | 3,000,000 | R. below Red Willow Ck, |
| **SPILLWAY** | | | | | | | | | conc ogee weir w/2-10x16 |
| Location | Left Abutment | Left Abutment | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Center of Dam | Right Abutment | gates to rivr, 2-10'x3' gates |
| Crest Elevation, feet msl | 3,710.0 | 2,743.0 | 3,097.0 | 2,604.9 | 2,386.2 (see also below) | 2,296.0 | 1,943.5 | 1,575.3 | to canal, max cap 130 cfs. |
| Width, feet | 121.5 | 142 | 361 | 31.5 (circ morning glory) | 229 | 106 | 856 | 53 | Franklin pumps on Rep R. |
| Number, Size, and Type of Gates | None (see notes below) | 3 - 42' x 30' Radial | 6 - 50' x 30' Radial | None | None | 3 - 30'x36.35' Radial | 18 - 40'x30' Radial | 2 - 25'x20' Radial | blw Harlan Cty, cap 40 cfs. |
| Disch. Cap. Top of Surcharge Pool | 73,300 cfs (with sluice) | 126,000 cfs | 202,000 cfs (with notch) | 4,910 cfs | 99,000 cfs (with notch) | 96,000 cfs | 480,000 cfs | 35,000 cfs | Courtland Div Dam, Rep R |
| **RESERVOIR (3)** | | | | | | | | | **TOTALS** |
| Surcharge Pool Elev (ft msl), Area | 3,736.2 8,579 ac | 2,785.0 10,035 ac | 3,129.5 ft msl 2,557 ac | 2,628.0 ft msl 4,079 ac | 2,408.9 ft msl 5,784 ac | 2,341.0 ft msl 6,713 ac | 1,975.5 ft msl 24,339 ac | 1,610.3 ft msl 7,635 ac | 69,721 ac |
| Flood Cntrl Pool Elev (ft msl), Area | 3,710.0 5,036 ac | 2,773.0 7,940 ac | 3,127.0 ft msl 2,405 ac | 2,604.9 ft msl 2,681 ac | 2,386.2 ft msl 3,483 ac | 2,331.4 ft msl 5,316 ac | 1,973.5 ft msl 23,431 ac | 1,595.3 ft msl 5,024 ac | 55,316 ac |
| MP, or Top Cons Pool Elev, Area | 3,672.0 2,042 ac | 2,752.0 4,922 ac | 3,112.3 ft msl 1,707 ac | 2,581.8 ft msl 1,621 ac | 2,366.1 ft msl 1,840 ac | 2,304.3 ft msl 2,181 ac | 1,945.73 msl 13,305 ac | 1,582.6 ft msl 2,987 ac | 30,605 ac |
| Inactive Pool Elev (ft msl), Area | 3,638.0 331 ac | 2,720.0 1,411 ac | 3,082.4 ft msl 627 ac | 2,558.0 ft msl 715 ac | 2,343.0 ft msl 701 ac | 2,280.4 ft msl 575 ac | 1,932.5 ft msl 9,282 ac | 1,571.7 ft msl 1,495 ac | 15,137 ac |
| Dead Stor Pool Elev (ft msl), Area | 3,635.5 242 ac | 2,710.0 488 ac | 3,080.0 ft msl 567 ac | 2,552.0 ft msl 536 ac | 2,335.0 ft msl 481 ac | 2,275.0 ft msl 317 ac | 1,885.0 ft msl 0 ac | 1,562.07 ft msl 494 ac | 3,125 ac |
| Surcharge Storage, AF | 3,736.2 - 3,710 178,230 | 2,785 - 2,773 107,610 | 3,129.5 - 3,127 6,203 | 2,628.0 - 2,604.9 76,829 | 2,408.9 - 2,386.2 105660 | 2,341.0 - 2,331.4 58,287 | 1,975.5 - 1,973.5 47,767 | 1,610.3 - 1,595.3 94,145 | 674,731 AF |
| Flood Control Storage, AF | 3,710.0 - 3,672 128,820 | 2,773 - 2,752 134,077 | 3,127.0 - 3,112.3 30,048 | 2,604.9 - 2,581.8 48,846 | 2,386.2-2,366.1 52,715 | 2,331.4 - 2,304.3 99,230 | 1,973.5 - 45.73 500,000 | 1,595.3 - 1,582.6 50,465 | 1,044,201 AF |
| MP, or Active Conserv Storage, AF | 3,672.0 - 3,638 39,206 | 2,752 - 2,720 99,784 | 3,112.3 - 3,082.4 33,962 | 2,581.8 - 2,558 27,303 | 2,366.1 - 2,343 26,846 | 2,304.3 - 2,280.4 30,517 | 1,945.73 - 32.5 150,000 | 1,582.6 - 1,571.7 24,022 | 431,640 AF |
| Inactive Storage, AF | 3,638.0 - 3,635.5 716 | 2,720 - 2,710 10,312 | 3,082.4 - 3,080 1,432 | 2,558.0 - 2,552 3,736 | 2,343.0 - 2,335 4,699 | 2,280.4 - 2,275 2,357 | 1,932.5 - 1,890 164,111 | 1,571.7 - 1,562.07 9,985 | 197,348 AF |
| Dead Storage, AF | 3,635.5 - 3,617 1,418 | 2,710 - 2,701 2,118 | 3,080.0 - 3,050 7,516 | 2,552.0 - 2,527 5,185 | 2,335.0 - 2,318.5 4,160 | 2,275.0 - 2,262 1,636 | Sluice crest at 1,885 0 | 1,562.07 - 1,550.0 1,659 | 23,692 AF |
| Gross Storage, AF | 3,710.0 - 3,617 170,160 | 2,773 - 2,701 246,291 | 3,127.0 - 3,050 72,958 | 2,604.9 - 2,527 85,070 | 2,386.2 - 2,318.5 88,420 | 2,331.4 - 2,262 133,740 | 1,973.5 - 1,890 814,111 | 1,595.3 - 1,550.0 86,131 | 1,696,881 AF |
| Design Sediment Reserve Storage | 8,000 AF for 50 years | 51,000 AF for 50 years | 4,000 AF for 100 years | 10,000 AF for 50 years | 15,000 AF for 50 years | 6,000 AF for 50 years | 200,000 AF for 100 yrs | 8,000 AF for 50 years | |
| Measured Sediment Inflow | 160 AF/year (estimated) | 7,659 AF (1953 to 1982) | 1,572 AF (1950 to 1997) | 1,616AF (1961 to 1997) | 4,397 AF (1949 to 1981) | 1,617 AF (1964 to 2000) | 38,548 AF (1952 - 00) | 6,021 AF (1957 to 1995) | |
| **OUTLET WORKS** | | | | | | | | | at Guide Rock, conc ogee |
| Location | Left Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | Left Abutment | Center of Dam | Right Abutment | w/2-20'x12' gates to river |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Sluices | Spillway gates used for | 5-10'x6'gates to Courtland |
| Number and Size of Conduit | 1 – 56" Cond to 26" Pipe | 2 - 6' x 7.5' | 1 - 84" Cond to 84"Pipe | 1 - 82" | 1 – 84" Cond to 44" Pipe | 1 – 48" Cond to 38" Pipe | 9 - 5'x8' thru Spillway | river releases. Gated | canal (cap 751 cfs), 1-10x6 |
| Length of Conduit, feet | 831.5 | 86.74 | 516 | 553.5 | 553 | 495 to Gate, 145 to Basin | | wasteway with 1-10'x9' | gate to Superior (cap 139). |
| Entrance Crest Elevation | 3,635.5 ft msl | 2,710.0 ft msl | 3,080.0 ft msl | 2,552.0 ft msl | 2,335.0 ft msl | 2,275.0 ft msl | 1,885.0 ft msl | radial gate from outlet | Other private diversion |
| Disch Cap, Top of Flood Cntrl Pool | 140 cfs (approx) | 4,300 cfs | 1,430 cfs | 1,170 cfs | 398 cfs (max elev 2,379) | 312 cfs | 20,700 cfs | canal to stilling basin. | weirs exist on some creeks |
| Disch Cap, Top of MP (Consv) Pool | 103 cfs | 3,500 cfs | 1,300 cfs | 990 cfs | 361 cfs | 257 cfs | 17,370 cfs | Wasteway is not used. | like Riverside blw Enders |
| Service Gates, Number, Size, Type | 1 - 24" Hollow Jet Valve | 2 - 6' x 7.5' Slide Gates | 2-60" Hollow Jet Valves | 2 - 42" Slide Gates | 1 - 39" Slide Gate | 1 - 33" Slide Gate | 9 - 5' x 8' Slide Gates | None | but div capacity minimal. |
| Provision for Irrigation | 1 - 32" Pipe to 24" Valve | 1 - 56" Pipe to 4' Gate | None | None | None | None | 1-5.5'; 1-2.83' Conduits | 1 - 8'x10' Gated Outlet | (5) 13,536 sq mi total |
| Provision for Power | Note: Storage owned by | None | None | None | None | None | 12'x12' Plug for 9' Cond | None | contributing with u/s dams. |
| Provision for Municipal Supply | CO for F&W, Recreation | None | None | None | None | 1 - 16" Pipe to 16" Gate | None | None | ac = acres ft = feet |
| Other Outlet | 1 - 40" Capped Conduit | None | None | None | None | None | Notes: USBR can distrib | Note: Inflow to lake also | AF = acre-feet |
| | | | | | | | water equitably to canals | provided from gated | cfs = cubic feet per sec |
| | Notes: Spillway also has 16.5'x21.5' sluice, with 1 - 16.5' x 10.75'gate, crest elev 3,672.0. The 56" gated outlet conduit feeds all three gated sub outlets. Capacity of irrig pipe outlet limited to 34.5 cfs by canal cap. | Notes: Irrigation outlet in right abutment. River outlets must be closed at pool elevations above 2,773.0. | Notes: Spillway also has an uncontrolled notch w/ crest elevation at 3112.3. Concrete ogee weir diversion dam 52 miles d/s, w/ 2-14' x 9.5' gates plus 30" gated condut to river, and 2- 10'x6' gates to canal (cap 400 cfs). | Note: Concrete ogee weir diversion dam 13 miles downstream, w/ 1-6'x18' radial gate to river, and 2 - 5'x4' regulating gates to canal (max cap 90 cfs) Bartley Diversion Dam located below Rep. R. confluence. See note (4) | Notes: Spillway also has an uncontrolled notch w/ crest elevation at 2366.1. Concrete ogee weir div-ersion dam at mile 301.6 on Rep. R. blw Med Ck. 2-10'x14'gates to river and 4-10'x14' gates to canal (max cap 325 cfs). | Notes: Concrete ogee weir diversion dam 17.6 miles downstream, with 1 – 6'x18' radial gate to river, 2 – 6'x5' gates to Main Canal (cap 100 cfs) and 2 – 5'x4' gates to South Canal (capacity 36 cfs). | of active consv storage. 1-18" outlet for low flow regulation in mono 20. Franklin Canal conduit to 2-36" gates, cap 520 cfs. Naponee Canal conduit to 1-24" valve, cap 40 cfs. See also note (4) | Courtland Canal outlet. | cfs = cubic feet per sec msl = elev abv mean sea lvl |

**SUMMARY OF ENGINEERING DATA**
**REPUBLICAN RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2001

Plate 2D

| SUBJECT | WACONDA LAKE | KIRWIN RESERVOIR | WEBSTER RESERVOIR | WILSON LAKE | KANOPOLIS LAKE | CEDAR BLUFF RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | (1) With pool at multipurpose or full conservation level. |
| Location of Dam | Near Glen Elder, KS | Near Kirwin, KS | Near Stockton, KS | Near Wilson, KS | Near Ellsworth, KS | Near Ellis, KS | (2) Damming height is height from original river bed to top of flood control pool. |
| Stream / River | Solomon River | North Fork Solomon River | South Fork Solomon River | Saline River | Smoky Hill River | Smoky Hill River | (3) Based on latest available storage data. The dates of the current area - capacity tables are indicated below along with the effective dates in parenthesis: |
| Miles above Mouth | 172.4 | 67.8 | 92.4 | 153.9 | 183.7 | 333.4 | Waconda, June 1971 (initial) |
| Contributing Drainage Area, sq miles | 2,559 below u/s dams (4) | 1,367 | 1,150 | 1,917 | 2,330 blw Cedar Bluff (6) | 5,365 | Kirwin, May 1996 (effective January 1, 1998) |
| Approx Length of Full Reservoir, miles (1) | 24 | 9 | 7 | 24 | 12 | 9 | Webster, May 1996 (effective January 1, 1998) |
| Shoreline, miles (1) | 100 | 37 | 27 | 100 | 41 | 50 | Wilson, December 1984 (effective January 1, 1985) |
| Maximum Discharge of Record nr Dam Site | 125,000 cfs (July 1951) | 24,000 cfs (Sep 1919) | 55,200 cfs (July 1951) | 25,700 cfs (Jul-Aug 1928) | 61,000 cfs (June 1938) | 98,000 cfs (May 1938) | Kanopolis, February 1983 (effective March 1, 1983) |
| Date of Closure | October 18, 1967 | March 7, 1955 | May 3, 1956 | September 3, 1963 | July 26, 1946 | November 13, 1950 | Cedar Bluff, March 2001 (effective January 1, 2002) |
| Date Storage Began | July 24, 1968 | October 5, 1955 | May 3, 1956 | December 29, 1964 | February 17, 1948 | November 13, 1950 | (4) Total DA with Kirwin and Webster = 5,076 sq miles |
| Date Multipurpose Level Reached | May 16, 1973 | July 2, 1957 | June 18, 1957 | March 12, 1973 | July 19, 1948 | June 21, 1951 | (5) 7’ conduit from intake tower to gate chamber. 4’x5’ emergency gate to 60” pipe. Entrance to stilling well controlled by 4’x5’ slide gate. From stilling well, 42” river outlet pipe controlled by 36” gate. River outlet capacity at top of MP pool and flood control pool about 220 cfs. Length of combined pipes from intake to stilling well about 500’. About 200’ more to stilling basin. Canal releases from two openings at top of stilling well. Canal capacity is about 175 cfs, but combined capacity with river outlet about 395 cfs. |
| Operating Agency | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Corps of Engineers | Corps of Engineers | Bureau of Reclamation | (6) Total contrib. DA with Cedar Bluff = 7,695 sq miles |
| **DAM AND EMBANKMENT** | | | | | | | |
| Top of Dam Elevation, feet msl | 1,500.0 | 1,779.0 | 1,944.0 | 1,592.0 | 1,537.0 | 2,198.0 | |
| Length of Dam, feet (Less Spillway) | 14,631 | 12,246 | 10,604 | 5,600 | 15,360 | 12,409.5 | |
| Damming Height, feet (2) | 107.9 | 95 | 84.7 | 114 | 102 | 102 | |
| Type of Fill | Earth | Earth | Earth | Earth | Earth | Earth | |
| Fill Quantity, cubic yards | 8,050,000 | 9,537,000 | 8,145,000 | 8,500,000 | 15,200,000 | 8,490,000 | |
| **SPILLWAY** | | | | | | | |
| Location | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | |
| Crest Elevation, feet msl | 1,467.4 | 1,757.3 | 1,884.6 | 1,582.0 | 1,507.0 | 2,166.0 | |
| Width, feet | 644 | 400 (uncontrolled) | 116 | 450 (uncontrolled) | 500 (uncontrolled) | 150.5 (uncontrolled length) | |
| Number, Size, and Type of Gates | 12 - 50’x21.76’ Radial | None, but see note below | 3 – 33.33’x39.51’ Radial | None | None | Gated orifice, see note blw | |
| Discharge Capacity at Top of Surcharge Pool | 278,000 cfs | 96,000 cfs (sluices closed) | 138,000 cfs | 15,700 cfs | 172,000 cfs | 84,000 cfs (with orifice) | |
| **RESERVOIR (3)** | | | | | | | **TOTALS** |
| Surcharge Pool Elevation (ft msl), Area | 1,492.9 ft msl 38,178 ac | 1,773.0 ft msl 14,660 ac | 1,938.0 ft msl 11,270 ac | 1,587.5 ft msl 33,882 ac | 1,531.8 ft msl 23,408 ac | 2,192.0 ft msl 16,510 ac | 137,908 ac |
| Flood Control Pool Elevation (ft msl), Area | 1,488.3 ft msl 33,682 ac | 1,757.3 ft msl 10,639 ac | 1,923.7 ft msl 8,478 ac | 1,554.0 ft msl 20,027 ac | 1,508.0 ft msl 13,958 ac | 2,166.0 ft msl 10,790 ac | 97,574 ac |
| Multipurpose, or Top Cons Pool Elev, Area | 1,455.6 ft msl 12,602 ac | 1,729.25 ft msl 5,071 ac | 1,892.45 ft msl 3,767 ac | 1,516.0 ft msl 9,045 ac | 1,463.0 ft msl 3,406 ac | 2,144.0 ft msl 6,869 ac | 40,760 ac |
| Inactive Pool Elevation (ft msl), Area | 1,428.0 ft msl 3,341 ac | 1,697.0 ft msl 1,006 ac | 1,860.0 ft msl 904 ac | | | 2,107.8 ft msl 1,907 ac | |
| Dead Storage Pool Elevation (ft msl), Area | 1,407.8 ft msl 350 ac | 1,693.0 ft msl 765 ac | 1,855.5 ft msl 440 ac | | | 2,090.0 ft msl 755 ac | |
| Surcharge Storage, AF | 1,492.9 - 1,488.3 164,966 | 1,773.0 - 1,757.3 198,467 | 1,938.0 - 1,923.7 140,912 | 1,587.5 - 1,554.0 894,263 | 1,531.8 - 1,508.0 438,655 | 2,192.0 - 2,166.0 353,250 | 2,190,513 AF |
| Flood Control Storage, AF | 1,488.3 - 1,455.6 722,315 | 1,757.3 - 1,729.25 215,136 | 1,923.7 - 1,892.45 183,353 | 1,554.0 - 1,516.0 530,204 | 1,508.0 - 1,463.0 369,278 | 2,166.0 - 2,144.0 191,890 | 2,212,176 AF |
| MP, or Active Conservation Storage, AF | 1,455.6 - 1,428.0 204,789 | 1,729.25 - 1,697.0 89,639 | 1,892.45-1,860.0 71,926 | 1,516.0 - 1,435.0 242,528 | 1,463.0 - 1,430.0 49,474 | 2,144.0 - 2,107.8 143,878 | 802,234 AF |
| Inactive Storage, AF | 1,428.0 - 1,407.8 35,435 | 1,697.0 - 1,693.0 3,546 | 1,860.0 - 1,855.5 2,975 | | | 2,107.8 - 2,090.0 24,172 | 66,128 AF |
| Dead Storage, AF | 1,407.8 - 1,386.0 1,236 | 1,693.0 - 1,680.0 4,969 | 1,855.5 - 1,849.0 1,256 | | | 2,090.0 - 2,078.0 4,402 | 11,863 AF |
| Gross Storage, AF | 1,488.3 - 1,386.0 963,775 | 1,757.3 - 1,680.0 313,290 | 1,923.7 - 1,849.0 259,510 | 1,554.0 - 1,435.0 772,732 | 1,508.0 - 1,430.0 418,752 | 2,166.0 - 2,078.0 364,342 | 3,092,401 AF |
| Design Sediment Reserve Storage | 23,750 AF for 50 years | 14,950 AF for 100 years | 18,600 AF for 100 years | 40,000 AF for 100 years | 51,500 AF for 50 years | 26,000 AF for 100 years | |
| Measured Sediment Inflow | 475 AF/year (estimated) | 1,278 AF (1955 to 1996) | 1,267 AF (1956 to 1996) | 15,066 AF (1964 to 1995) | 28,704 AF (1948 to 1993) | 13,044 AF (1950 to 2000) | |
| **OUTLET WORKS** | | | | | | | (7) In addition to the gated conduit, Kanopolis has an uncontrolled port opening 3.5’x13.75’ in the 10’ pier separating the two service gate openings. Crest elevation of the port is 1,463 ft msl. The max discharges given for the outlet is the combined total of the port and gates. (8) River outlet crest elev is 2,090 ft msl. Crest elev of sluices under spillway is 2,134.82 ft msl. River outlet capacity at MP is 804 cfs, at top of flood pool is 909 cfs. Cedar Bluff also has an irrig canal outlet on Y junction from river outlet, 5.5’ pipe to control house, canal flow controlled by 4’x5’ gate (not used since 1978, irrigation district disbanded in 1994). Also a hatchery supply line from 18” valve on canal outlet, capacity 10 cfs. Lake storage owned by KS, for benefit of recreation and F&W. All releases coordinated with Kansas KDWP. (9) 2,000 AF annual storage supply contract for Russell. |
| Location | Left Abutment | Center of Dam | Right Abutment | Right Abutment | Right Abutment | Left Abutment | |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit (7) | Gated Conduit to River | |
| Number and Size of Conduit | 1 - 12.5’ | 7’ Cond to 60” pipe (5) | 4.5’ Conduit to 48” pipe | 1 - 12’ | 1 - 14’ | 1 - 5.5’ | |
| Length of Conduit, feet | 575 | (5) | 538 | 1,097 | 2,443 | 863.5 | |
| Entrance Crest Elevation | 1,407.8 ft msl | 1,693 ft msl | 1,855.5 ft msl | 1,450 ft msl | 1,415 ft msl | 2,090 ft msl | |
| Gated Sluice, Number and Size | None | See note below | None | None | None | 8 - 5’x5’, gated (8) | |
| Discharge Cap, Top of Flood Control Pool | 5,200 cfs | 220 cfs (5) | 480 cfs | 6,500 cfs | 6,400 cfs (7) | 3,520 cfs (outlet, sluices) (8) | |
| Disch Cap, Top of MP (Conservation) Pool | 4,000 cfs | 220 cfs (5) | 385 cfs | 5,300 cfs | 4,500 cfs (7) | 7,949 cfs (outlet, sluices) (8) | |
| Service Gates, Number, Size, Type | 2 - 6.5’x8’ Slide Gates | 1 - 4’x5’ to stilling well (5) | 1 - 3.5’x3.5’ Slide Gate | 2 - 6’x12’ Service Gates | 2 - 6’x12’ | 1 - 4’x5’ | |
| Emergency Gates, Number and Size | 1 - 9’x12’ Slide Gates | 1 - 4’x5’ (5) | 1 - 3.5’x3.5’ Slide Gate | 2 - 6’x12’ Slide Gates | 1 - 6’x12’ | 1 - 4’x5’ | |
| Low Flow Gates, Number and Size | None | None | None | 2 - 2’x2’ Slide Gates | None | None | |
| Provision for Irrigation | None | 2 - 5.5’x8’ openings (5) | None | None | None | 1 - 4’x5’ (8) | |
| Provision for Power | None | None | None | None | See below | None | |
| Provision for Municipal Supply | Supplied thru river releases. | None | None | None | See below | Thru river releases (9), but | |
| | City of Beloit has contracted for up to 2,000 AF of annual storage releases. Mitchell County Rural Water District No. 2 has contracted for up to 1,009 AF of annual storage releases. | Note: 15 - 5’ x 5’ gated sluices located in concrete ogee section below spillway crest. Crest elevation at sluice entrance = 1,720.0. Discharge capacity at top of conserv pool = 4,800 cfs, top, flood pool = 15,350 cfs. | Note: When reservoir elevation is below 1,860, the outlet gate openings must be reduced to prevent air entrainment in conduit. | Note: Low flow gates are mounted in the service gates Low flow gates are used for river releases up to 200 cfs. | Provision for future steel penstock in outlet tunnel for power. Post Rock Irrigation District has supply contract to pump water to a supply pipe from an outlet in the lake near the intake tower. | no releases in recent years. Note: Spillway also has a gated orifice section at center with 1-14.5’x9.58’ radial gate, crest elev 2,144. Spillway cap includes ogee and orifice. Sluices located in ogee section below crest. | |

**Abbreviations**
ac = acres
AF = acre-feet
ft = feet
msl = elevation above mean sea level
cfs = cubic feet per second
MP = multipurpose pool elevation

**SUMMARY OF ENGINEERING DATA**
**SMOKY HILL RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2001

Plate 2E

**APPENDIX A**
**CORPS OF ENGINEERS PROJECTS**

BLUE SPRINGS LAKE

CLINTON LAKE

HARLAN COUNTY LAKE

HARRY S. TRUMAN RESERVOIR

HILLSDALE LAKE

KANOPOLIS LAKE

LONG BRANCH LAKE

LONGVIEW LAKE

MELVERN LAKE

MILFORD LAKE

PERRY LAKE

POMME DE TERRE LAKE

POMONA LAKE

RATHBUN LAKE

SMITHVILLE LAKE

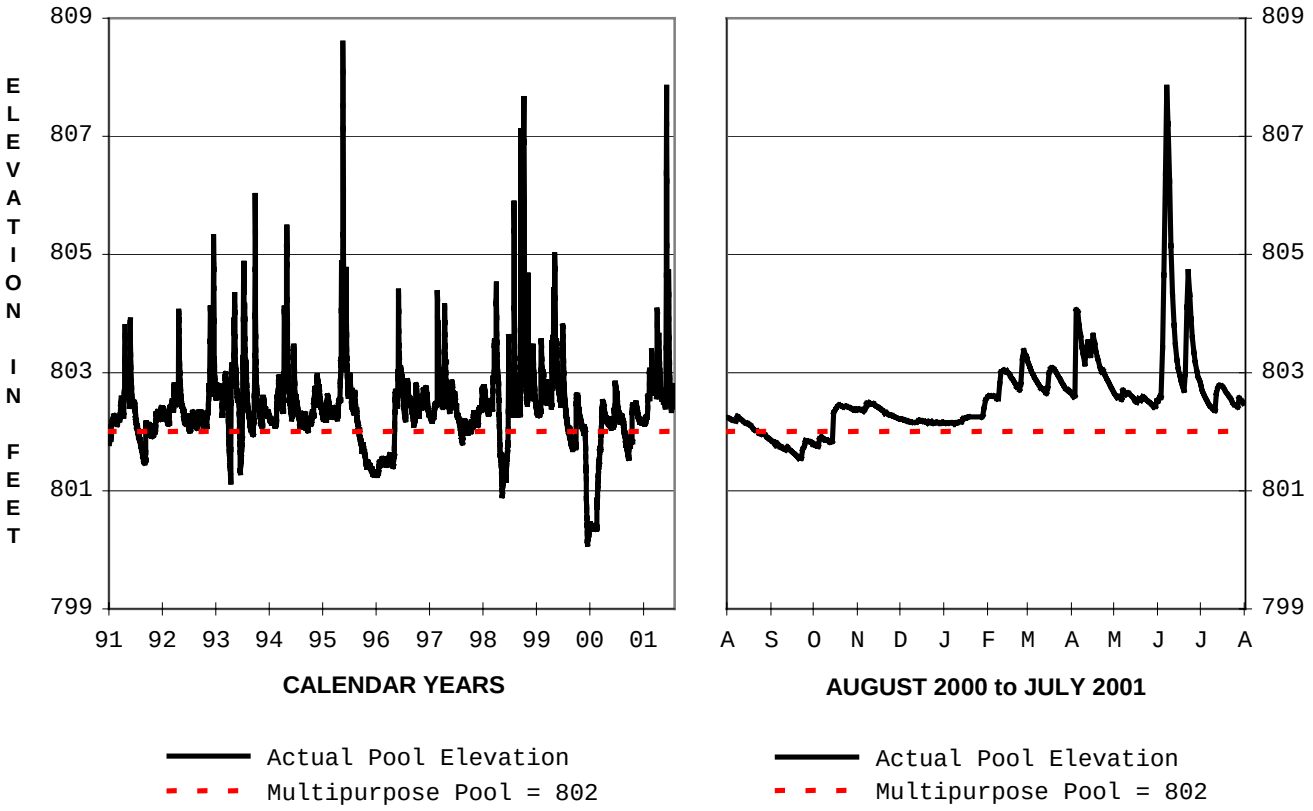
STOCKTON LAKE

TUTTLE CREEK LAKE

WILSON LAKE

# BLUE SPRINGS LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

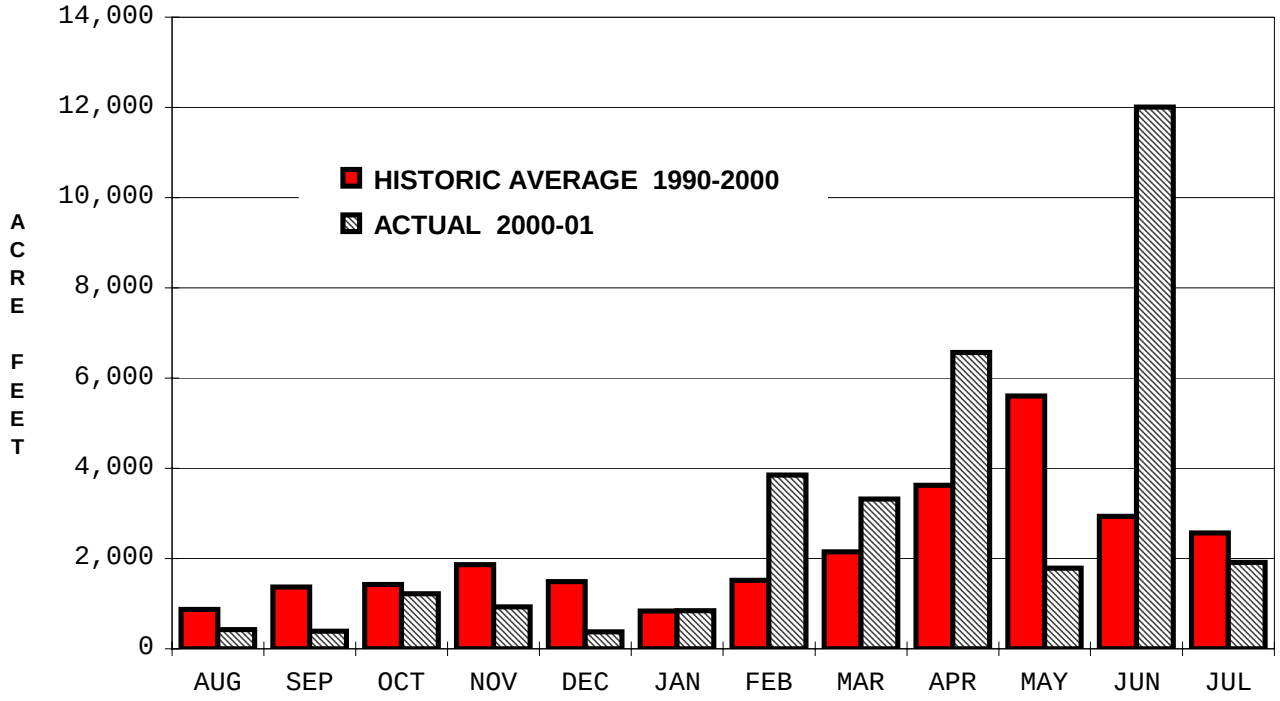



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **802.24<br>1 Aug 00** | **802.48<br>31 Jul 01** | **807.84<br>7 Jun 01** | **801.53<br>20 Sep 00** | **816.37<br>16-17 May 90** | **800.10<br>14-15 Dec 99** |

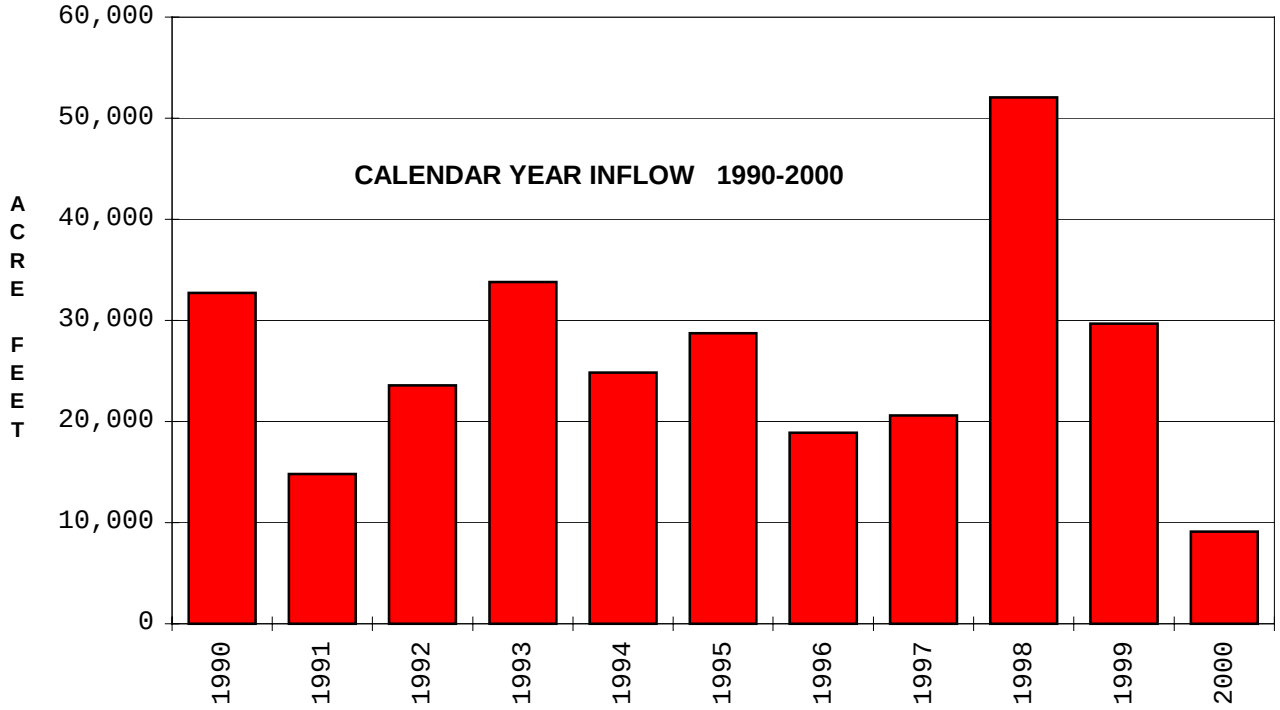
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **1,100<br>6-7 Jun 01** | **33,630 (123%)<br>8,887 AF previous period** | **511<br>8 Jun 01** | **0<br>23 Aug to 14 Oct 00** |

All releases are to the river. No minimum release requirement.

## BLUE SPRINGS LAKE MONTHLY INFLOW

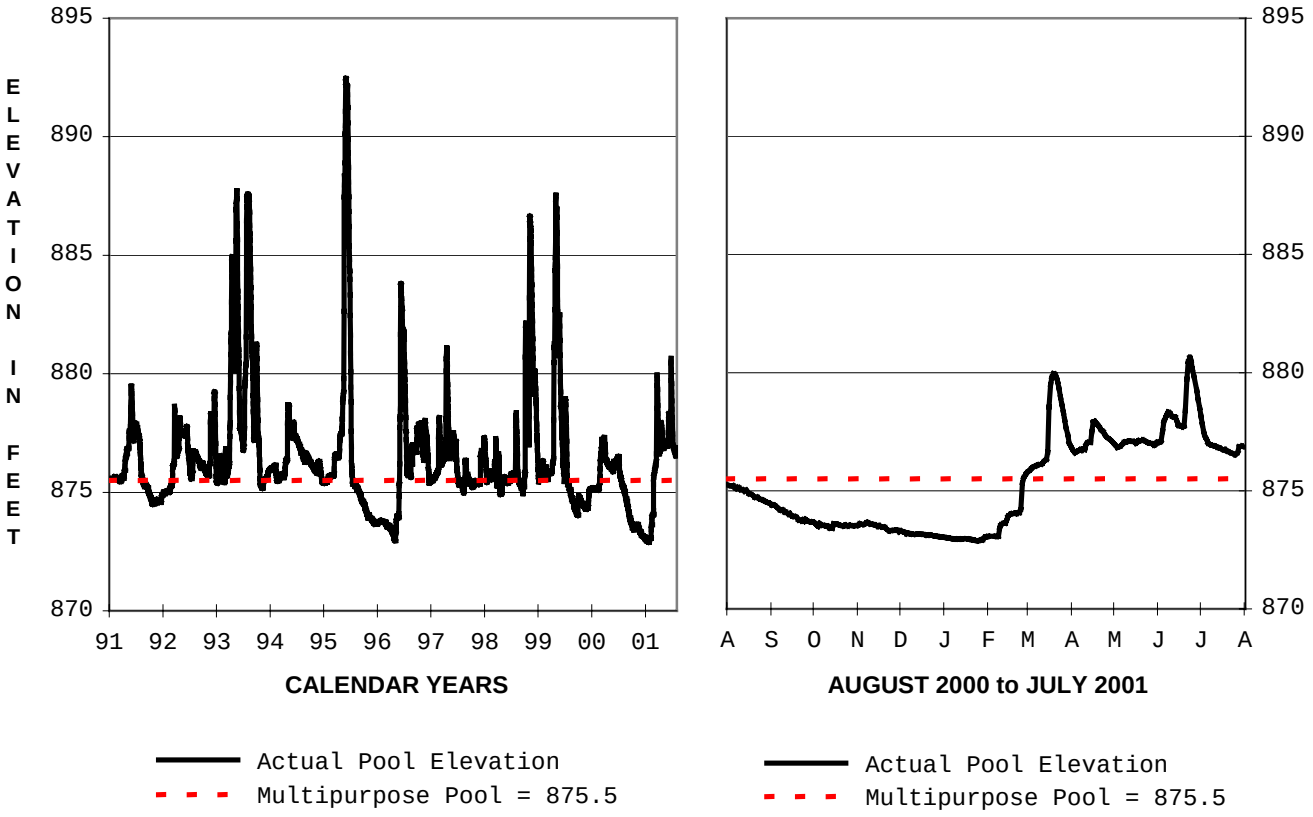



## BLUE SPRINGS LAKE ANNUAL INFLOW



# CLINTON LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

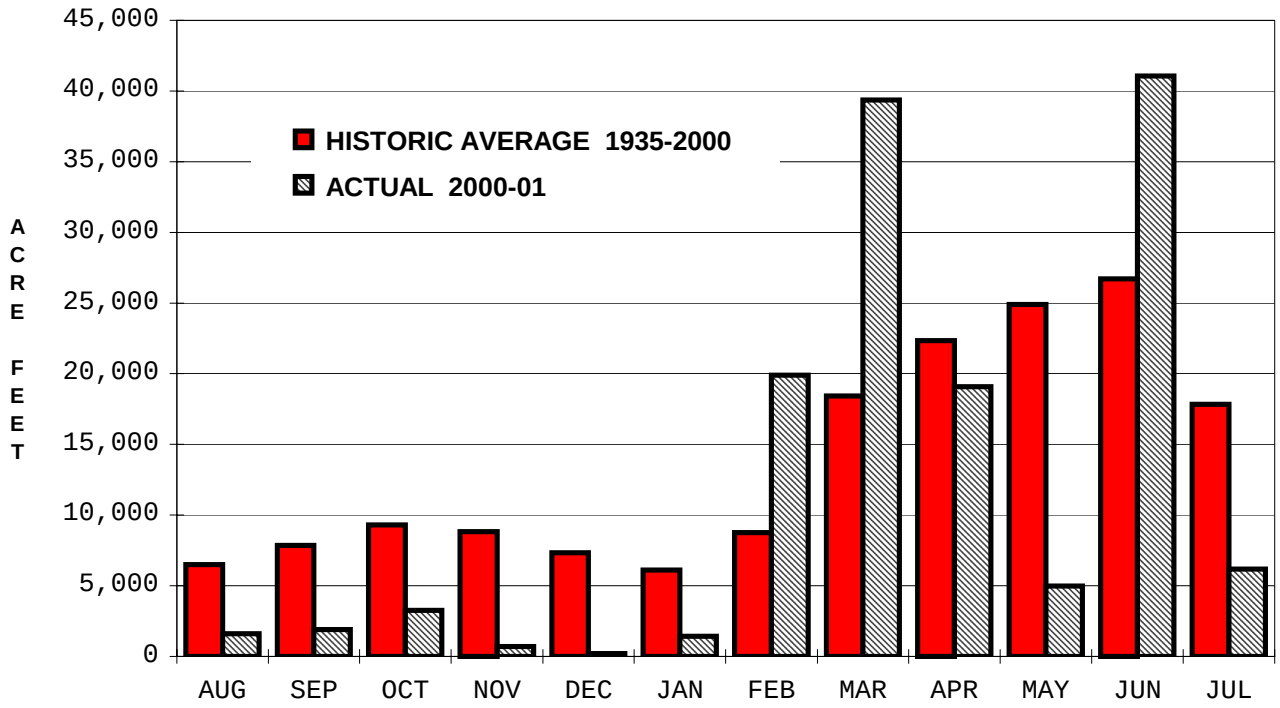



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **875.25<br>1 Aug 00** | **876.87<br>31 Jul 01** | **880.65<br>23 Jun 01** | **872.89<br>24-25 Jan 01** | **892.48<br>29 May 95** | **871.60<br>18-19 Aug 89** |

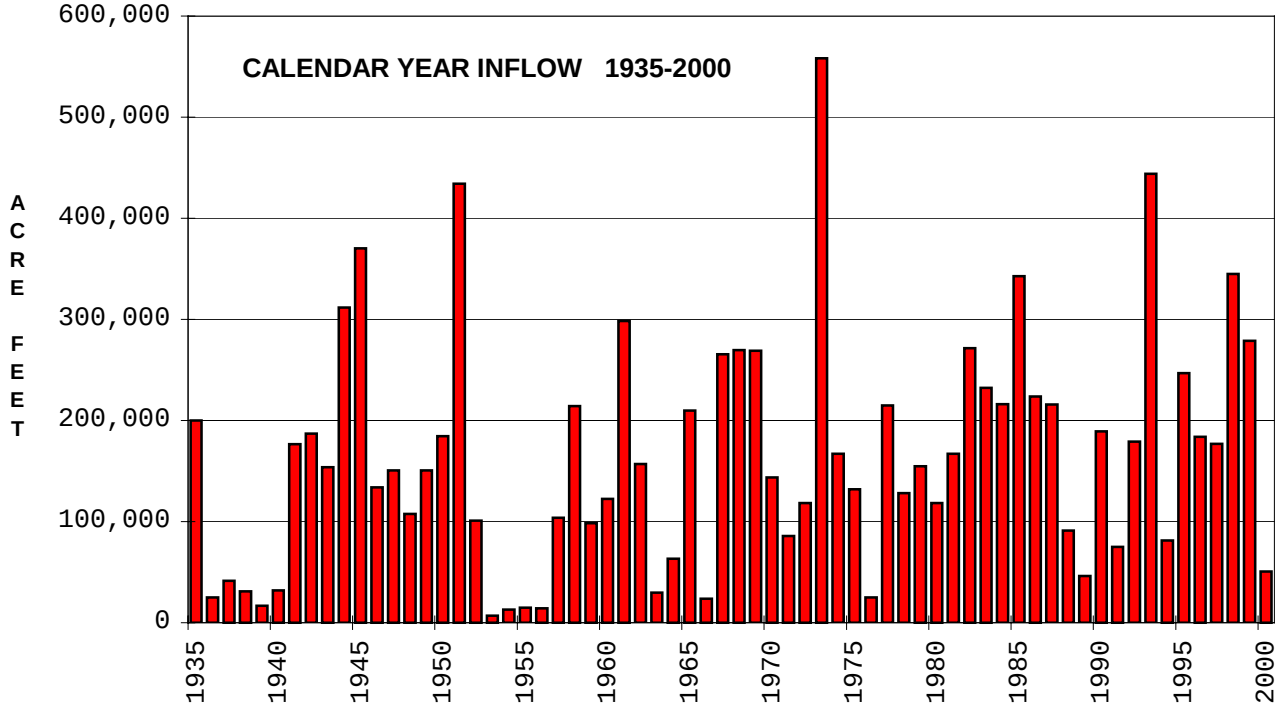
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **7,000<br>16 Mar 01** | **136,443 (83%)<br>62,024 AF previous period** | **1,500 25-30 Mar 01<br>25 Jun to 3 Jul 01** | **7<br>22 Oct 00 to 19 Mar 01** |

Outflows are those to river only. Minimum release is 7 to 21 cfs. Releases cut to 0 for short maintenance periods.

## CLINTON LAKE MONTHLY INFLOW

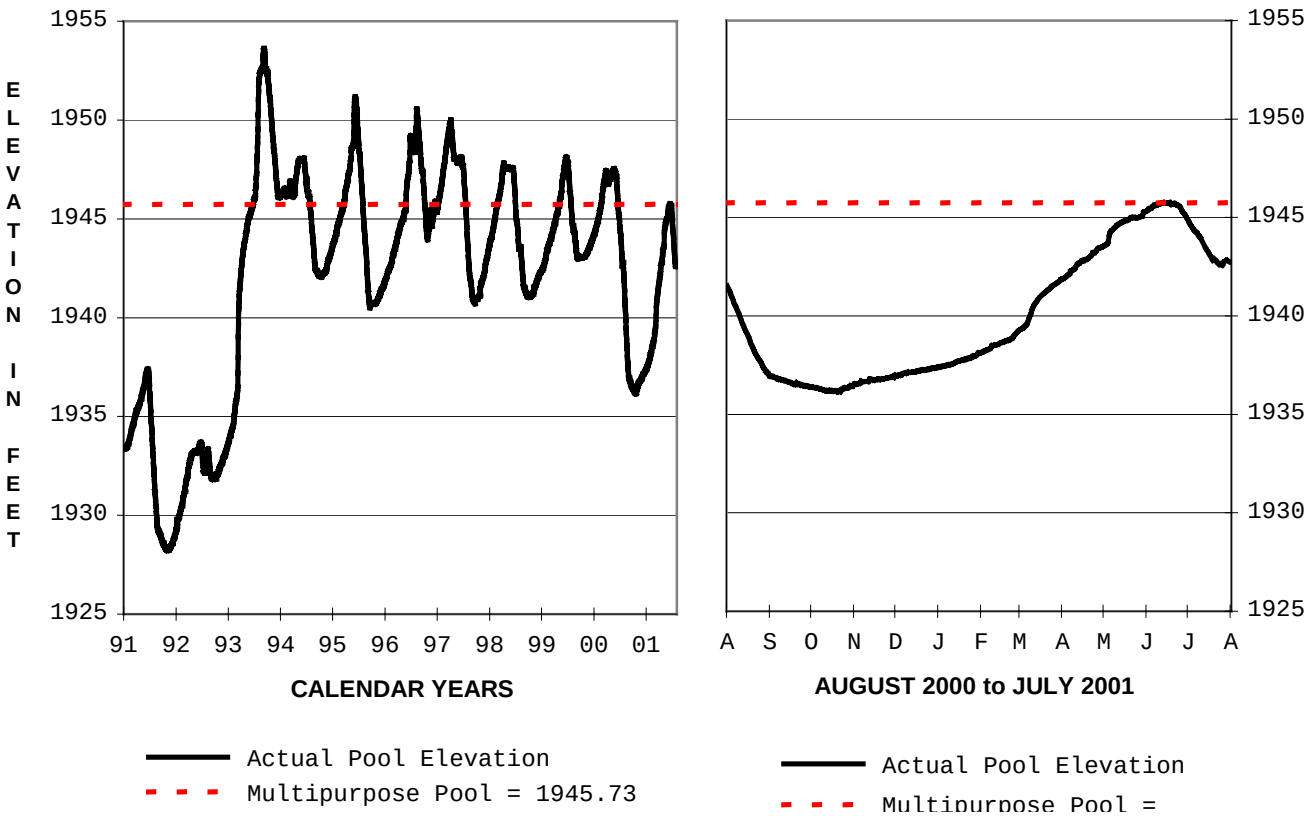



## CLINTON LAKE ANNUAL INFLOW



# HARLAN COUNTY LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

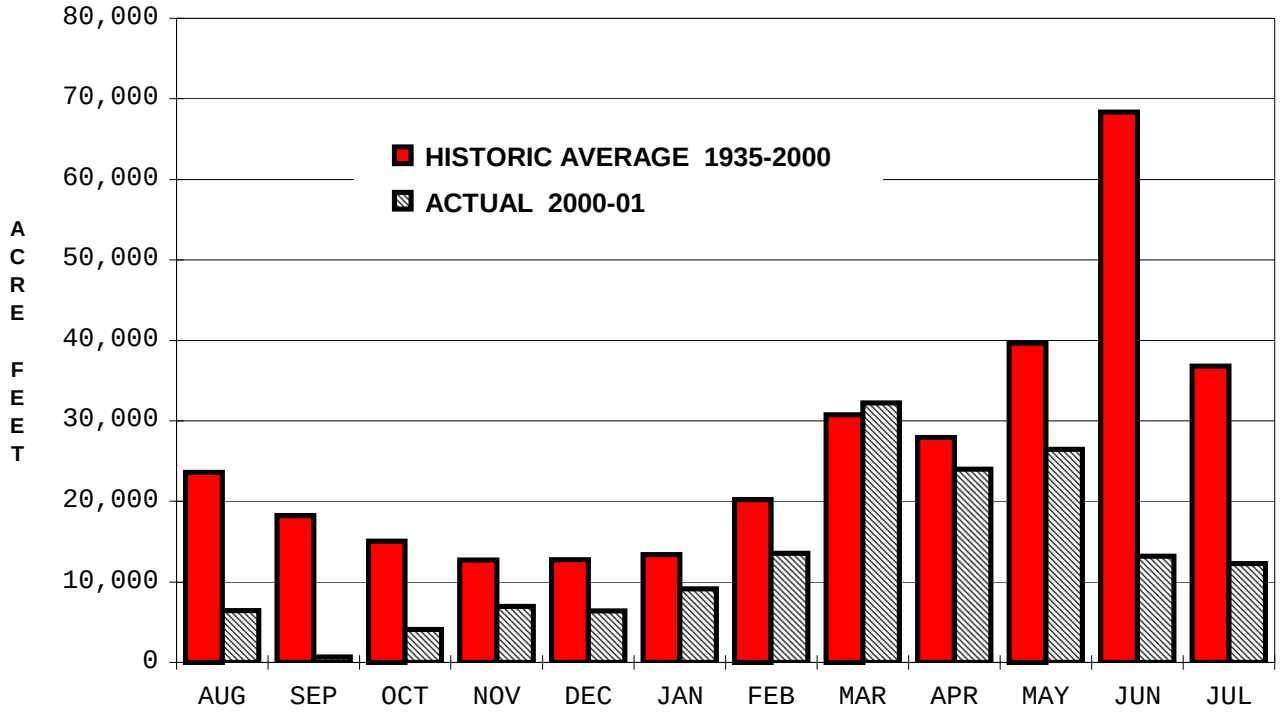



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1941.53<br>1 Aug 00** | **1942.74<br>31 Jul 01** | **1945.79<br>14 Jun 01** | **1936.14<br>21 Oct 00** | **1955.66<br>5 Apr 60** | **1928.21<br>27-28 Oct 91** |

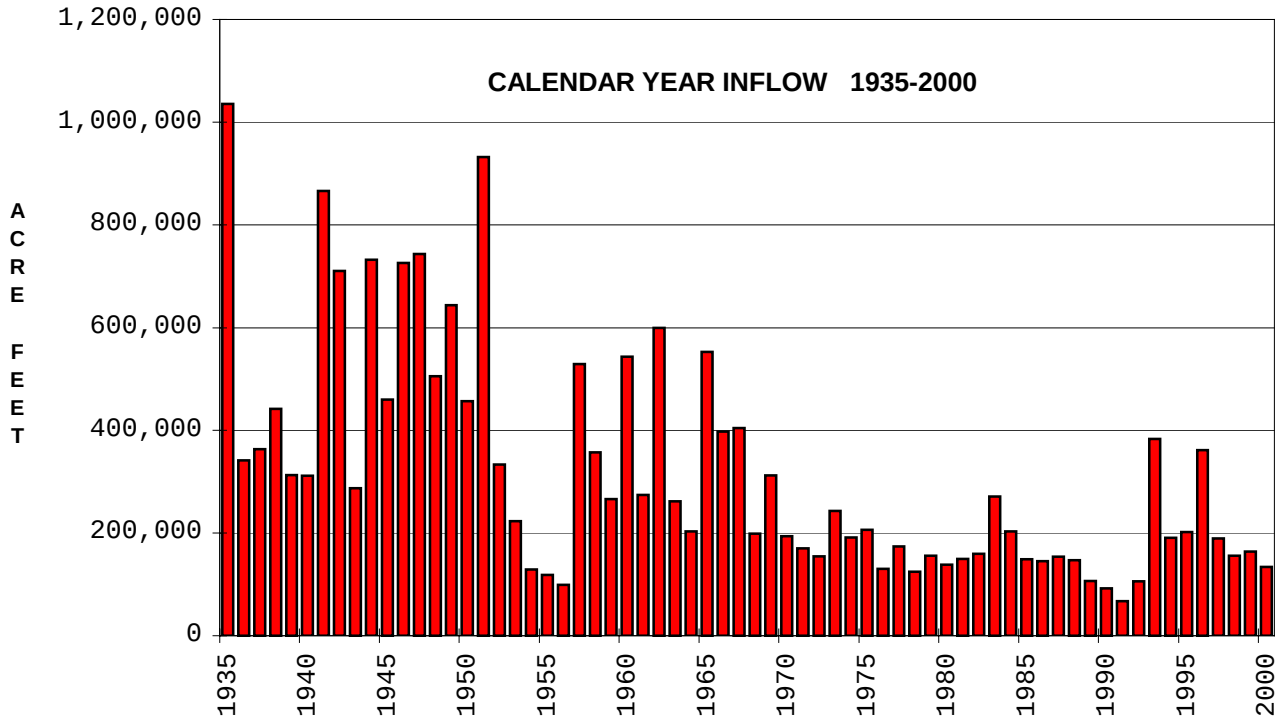
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,700<br>5 May 01** | **155,506 (49%)<br>159,976 AF previous period** | **725<br>1-4 Aug 00** | **0, minimum release varies from 0 to 10 cfs** |

Max daily outflow to river occurred as part of normal releases for irrigation. Max release w/2 canals was 1,012 cfs.

## HARLAN COUNTY LAKE MONTHLY INFLOW

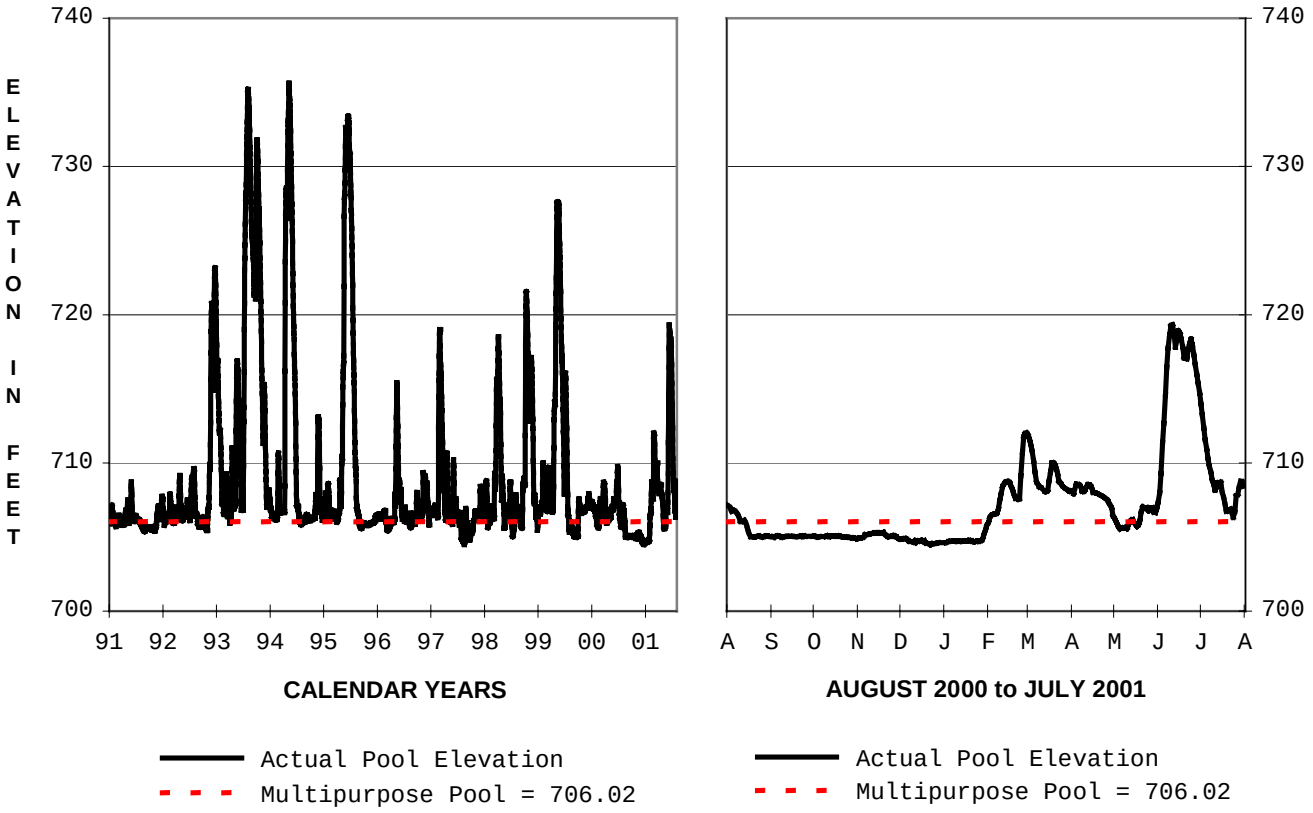



## HARLAN COUNTY LAKE ANNUAL INFLOW



# HARRY S. TRUMAN RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

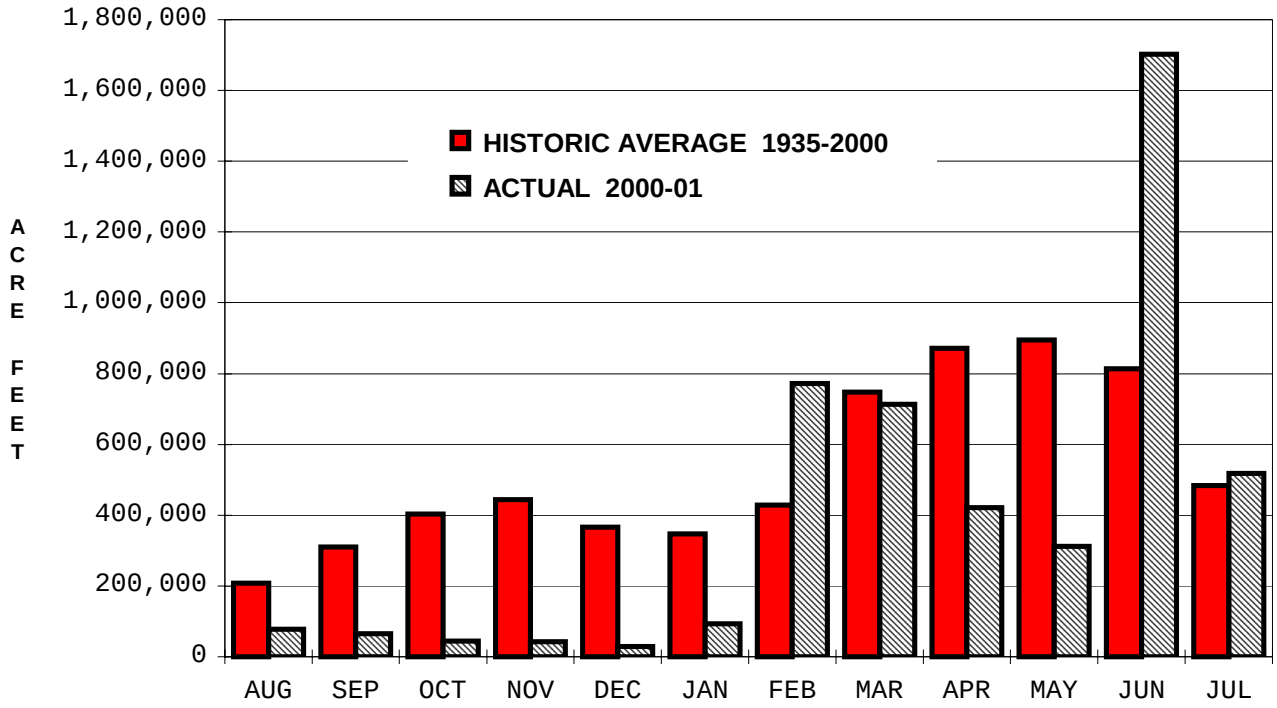



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **705.14<br>1 Aug 00** | **708.42<br>31 Jul 01** | **719.49<br>11 Jun 01** | **704.50<br>22-23 Dec 00** | **738.72<br>12 Oct 86** | **703.42<br>10 Apr 81** |

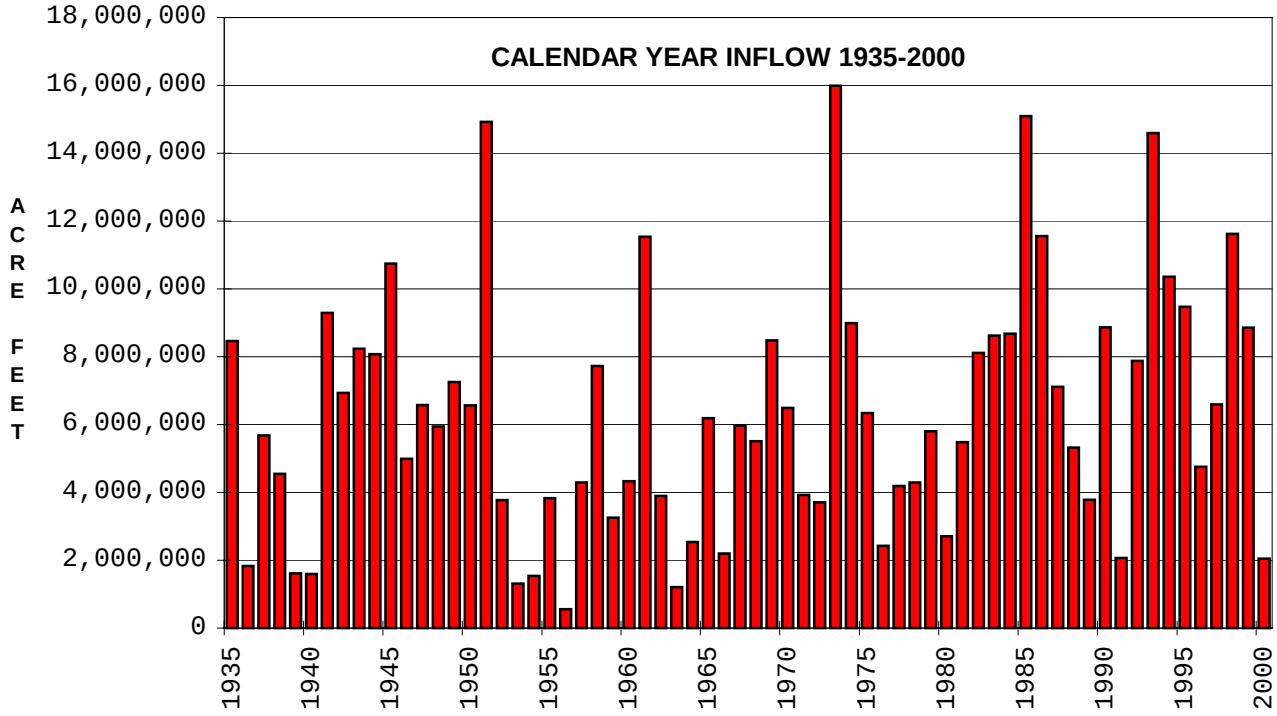
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Max Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **76,000<br>4, 6-7 Jun 01** | **4,789,548 (72%)<br>2,405,723 AF previous period** | **50,646<br>13 Jun 01** | **0<br>Several periods** |

Listed outflows include turbine releases and spill to the river. Minimum release varies during the year 0 to 3,500 cfs.

## HARRY S. TRUMAN RESERVOIR MONTHLY INFLOW

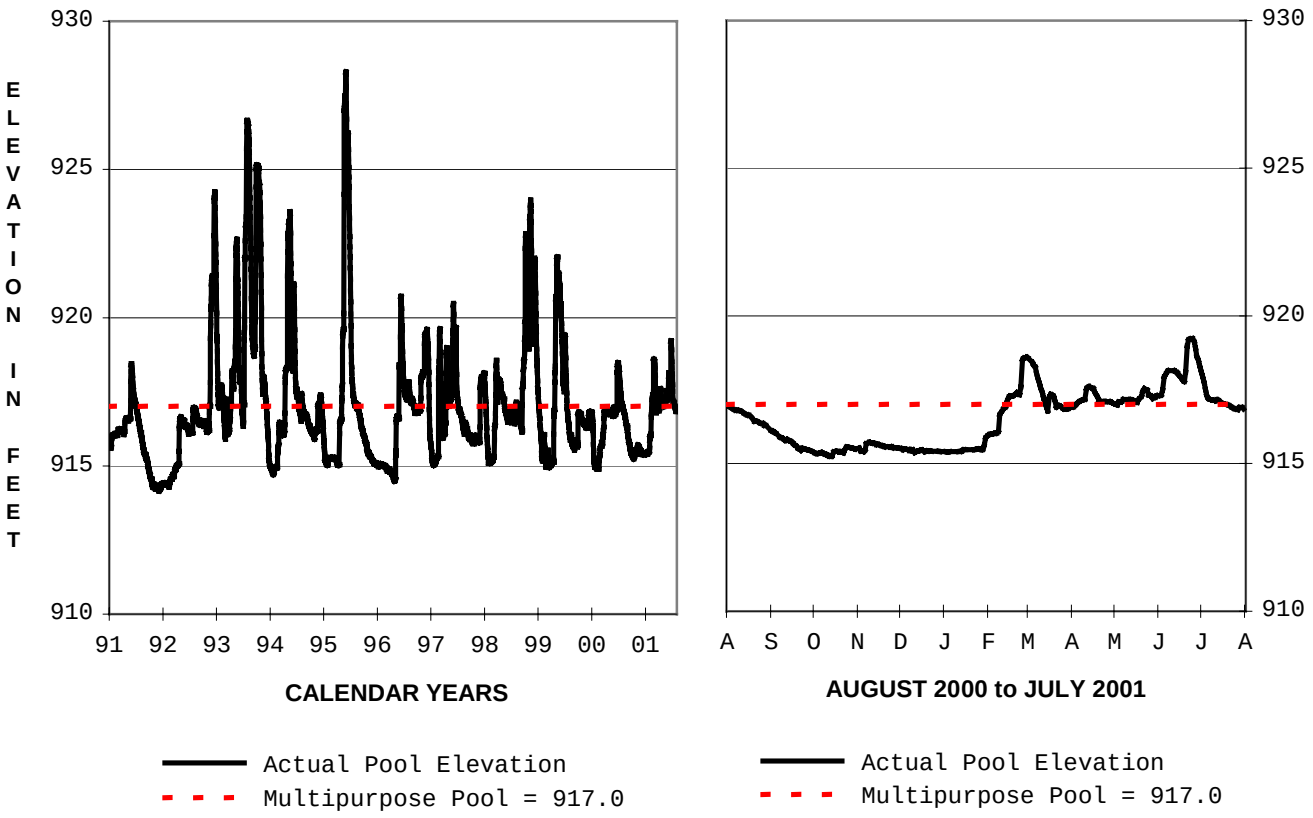



## HARRY S. TRUMAN RESERVOIR ANNUAL INFLOW



# HILLSDALE LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

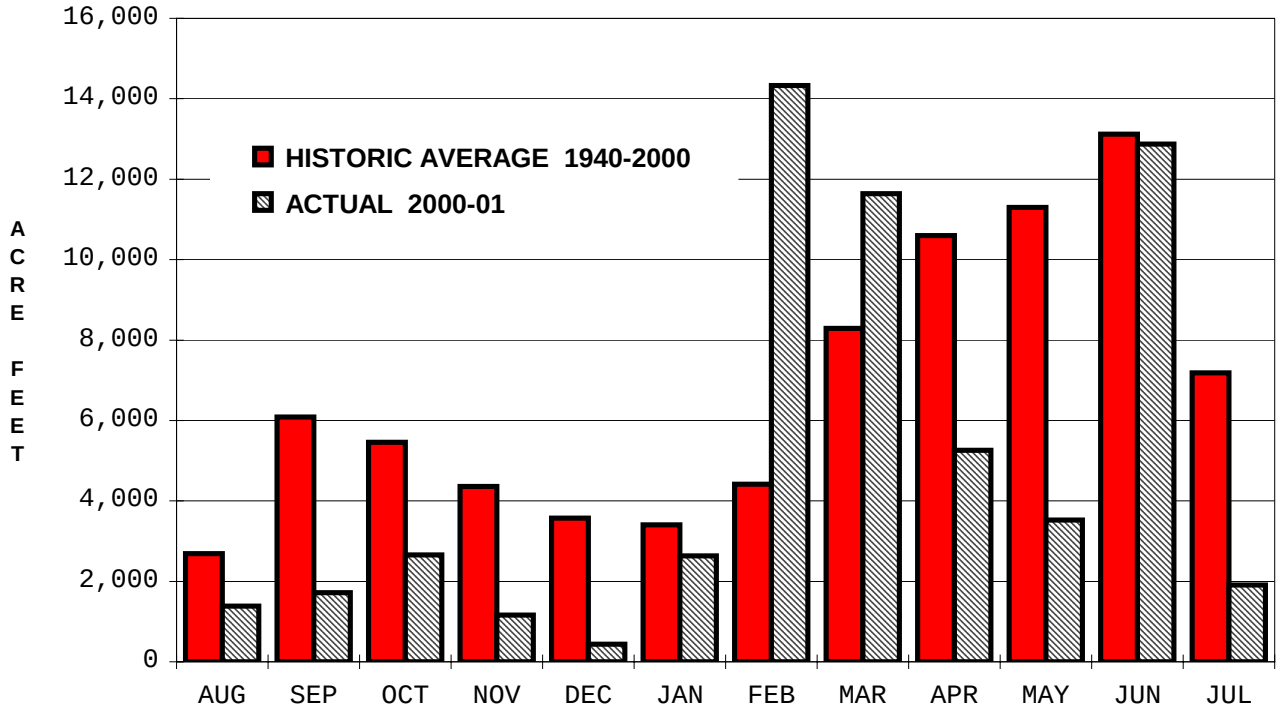



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **916.97<br>1 Aug 00** | **916.85<br>31 Jul 01** | **919.23<br>23-25 Jun 01** | **915.22<br>13 Oct 00** | **928.51<br>21 Oct 86** | **904.97<br>14-15 Nov 87** |

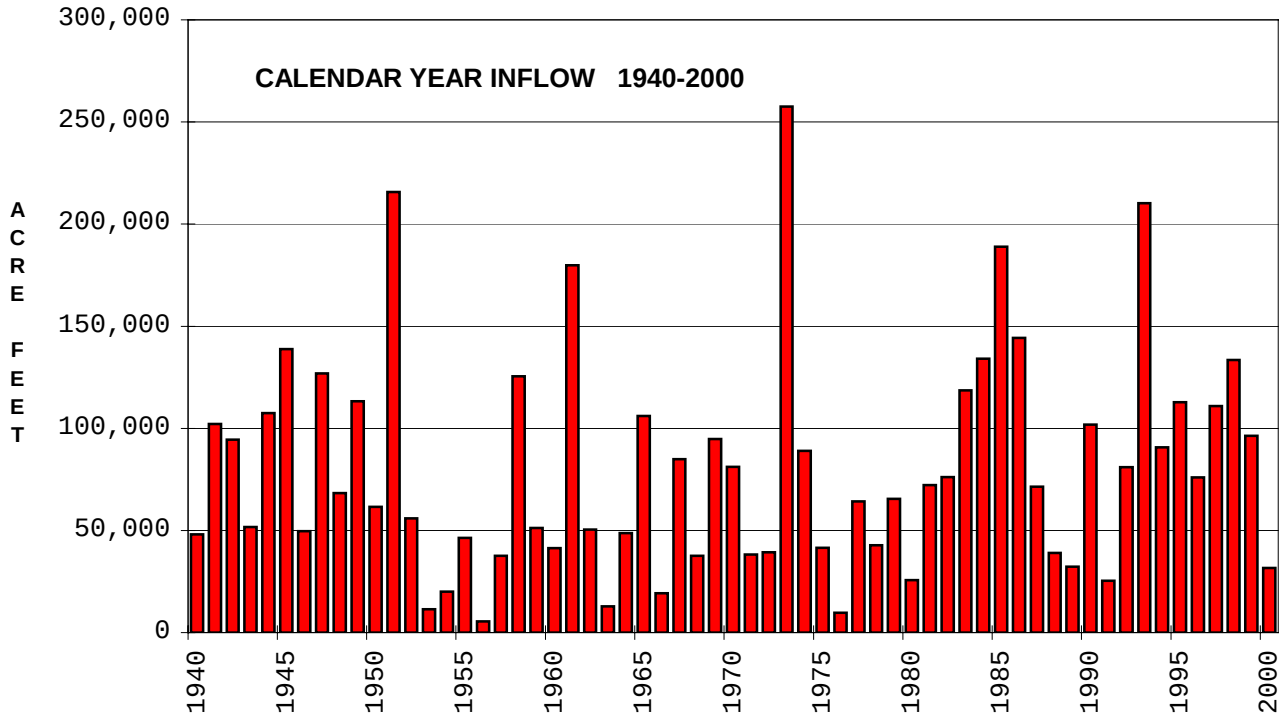
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,200<br>21 Jun 01** | **59,527 (74%)<br>39,837 AF previous period** | **500 7-20 Mar 01<br>27 Jun to 5 Jul 01** | **3<br>3 Nov 00 to 20 Feb 01** |

Listed outflows are to river. Minimum required release is 3-24 cfs. Releases cut to 0 for short maintenance periods.

## HILLSDALE LAKE MONTHLY INFLOW

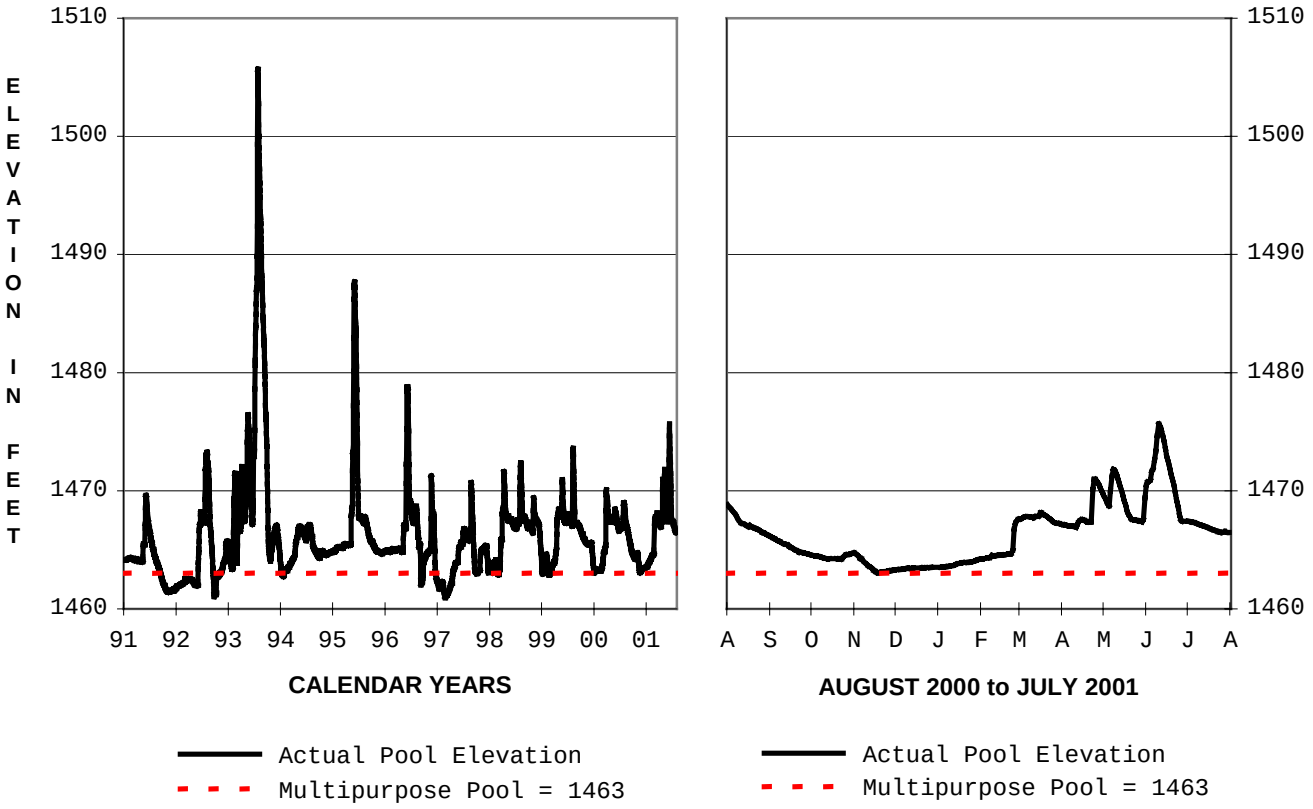



## HILLSDALE LAKE ANNUAL INFLOW



# KANOPOLIS LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

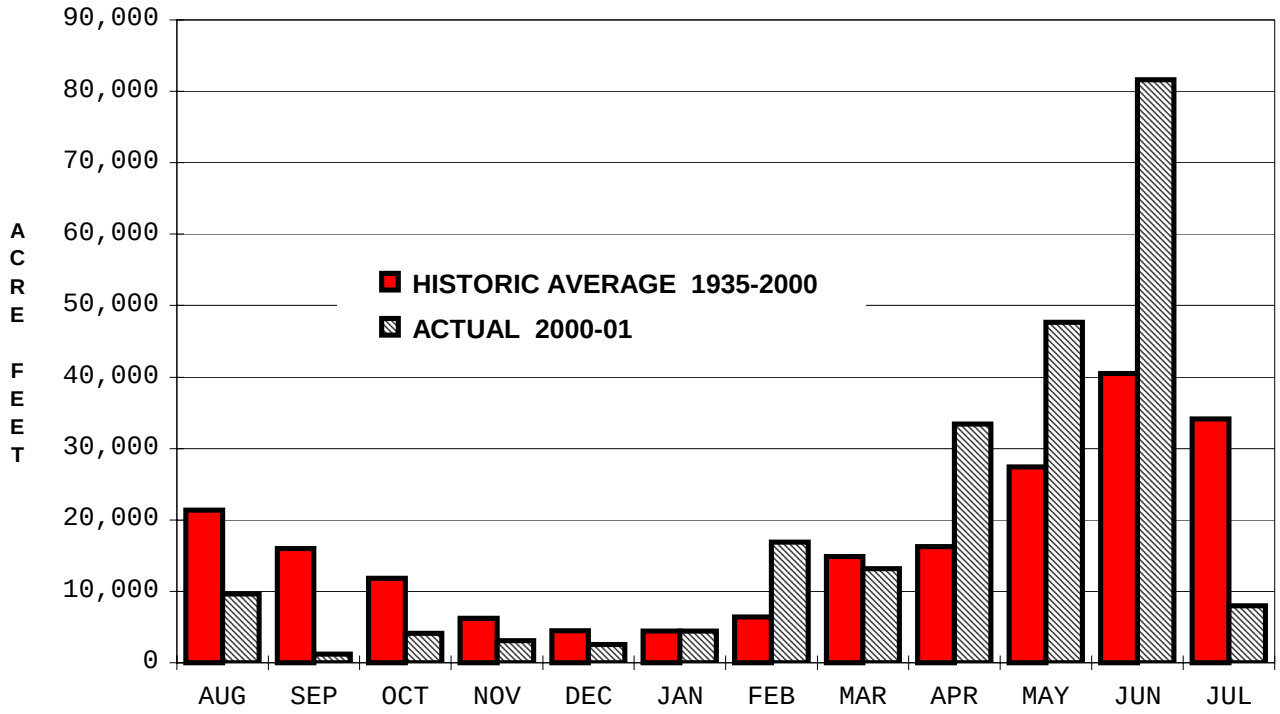



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1468.83<br>1 Aug 00** | **1466.46<br>31 Jul 01** | **1475.68<br>10 Jun 01** | **1463.06<br>17-18 Nov 00** | **1506.98<br>14 Jul 51** | **1452.55<br>11 Dec 88** |

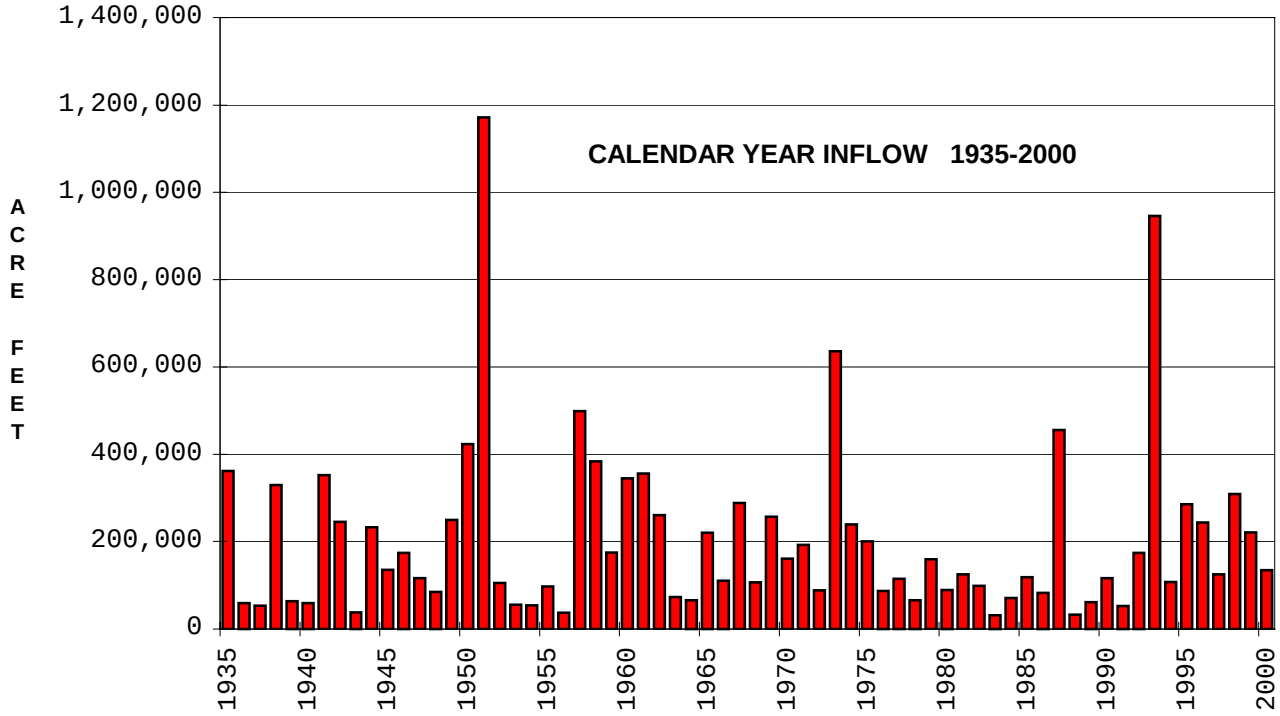
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **6,800<br>11 Jun 01** | **225,603 (110%)<br>203,356 AF previous period** | **2,368<br>11 Jun 01** | **1 (for maintenance)<br>19-23 Nov 00** |

Listed outflows are total from gates and uncontrolled notch. Minimum release varies seasonally 10 to 50 cfs.

## KANOPOLIS LAKE MONTHLY INFLOW

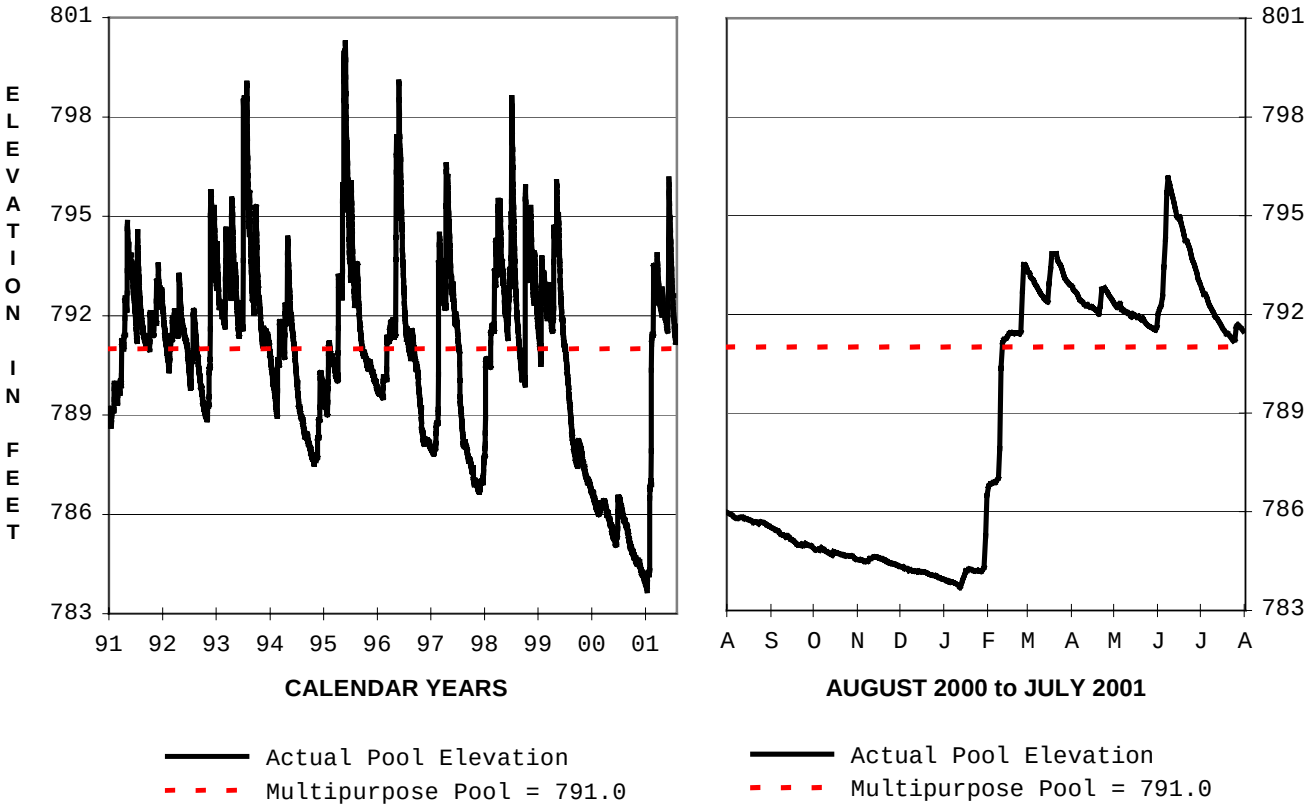



## KANOPOLIS LAKE ANNUAL INFLOW



# LONG BRANCH LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

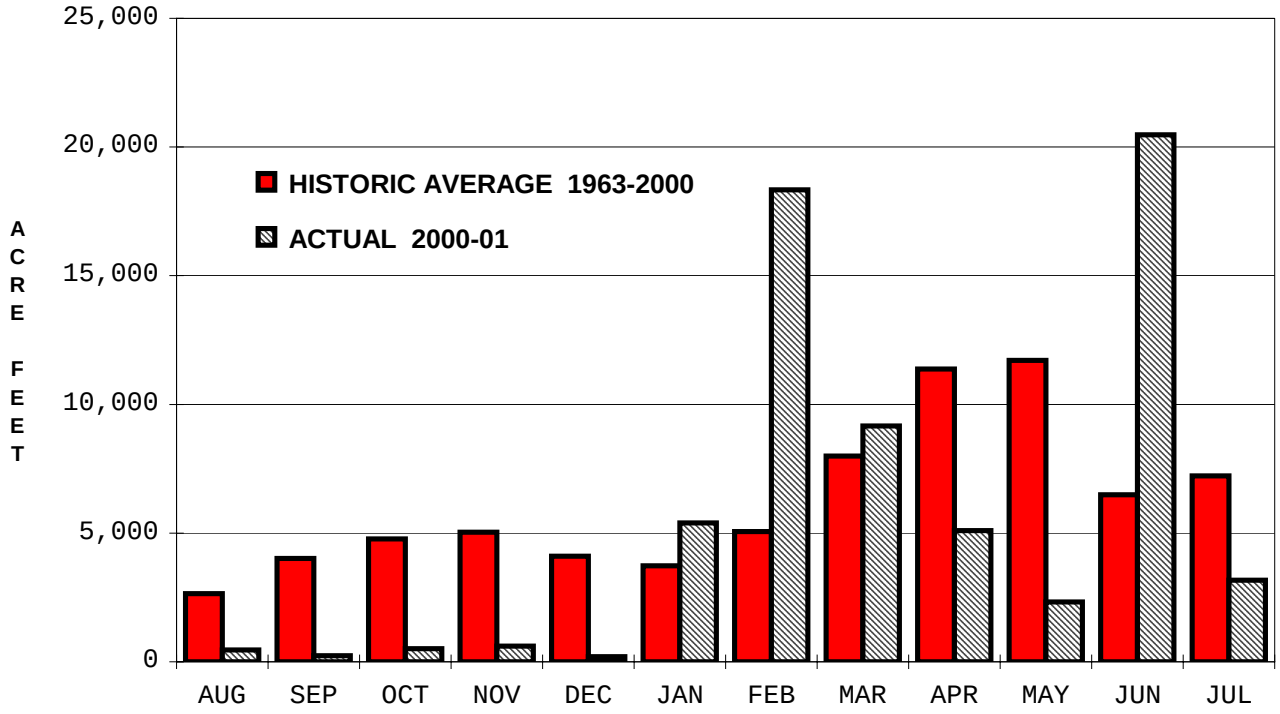



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **785.97<br>1 Aug 00** | **791.49<br>31 Jul 01** | **796.17<br>7-8 Jun 01** | **783.70<br>12 Jan 01** | **800.40<br>28 May 95** | **783.70<br>12 Jan 01** |

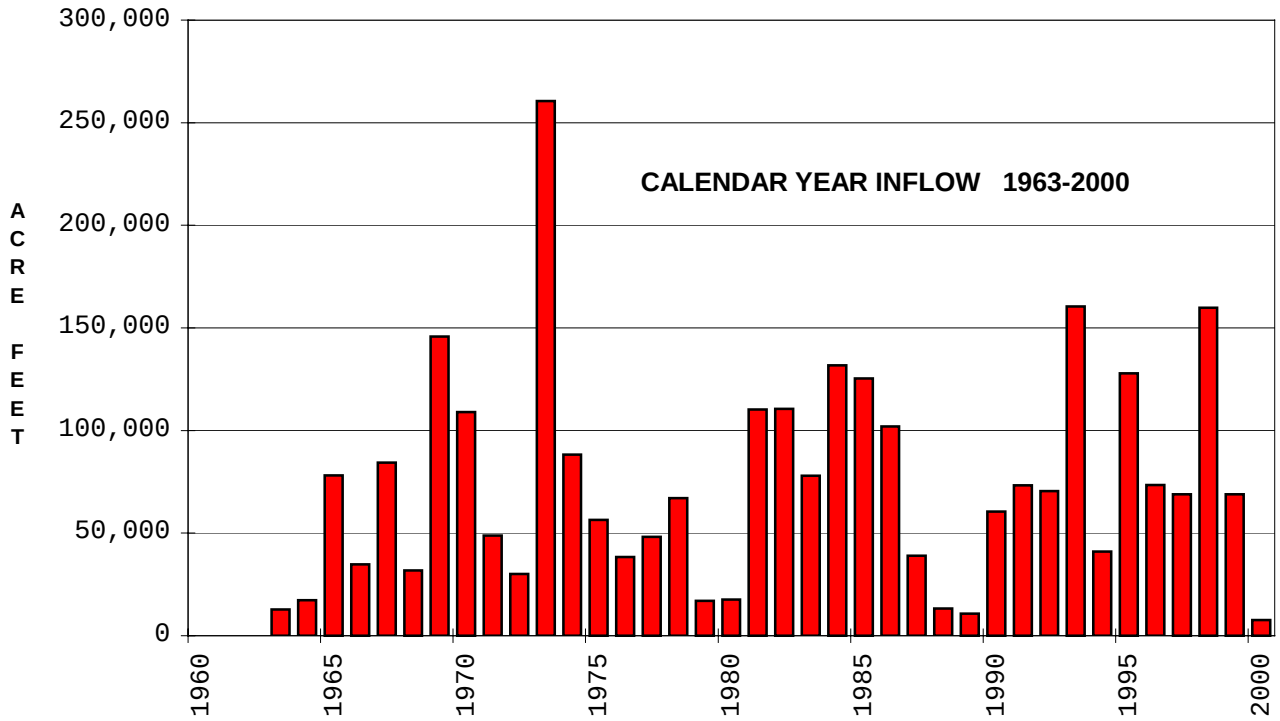
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,500<br>10 Feb 01** | **65,967 (88%)<br>8,370 AF previous period** | **447<br>9 Jun 01** | **7<br>1 Aug 00 to 10 Feb 01** |

Listed outflows are total to the river from the gates and the uncontrolled notch. Minimum required release is 7 cfs.

## LONG BRANCH LAKE MONTHLY INFLOW

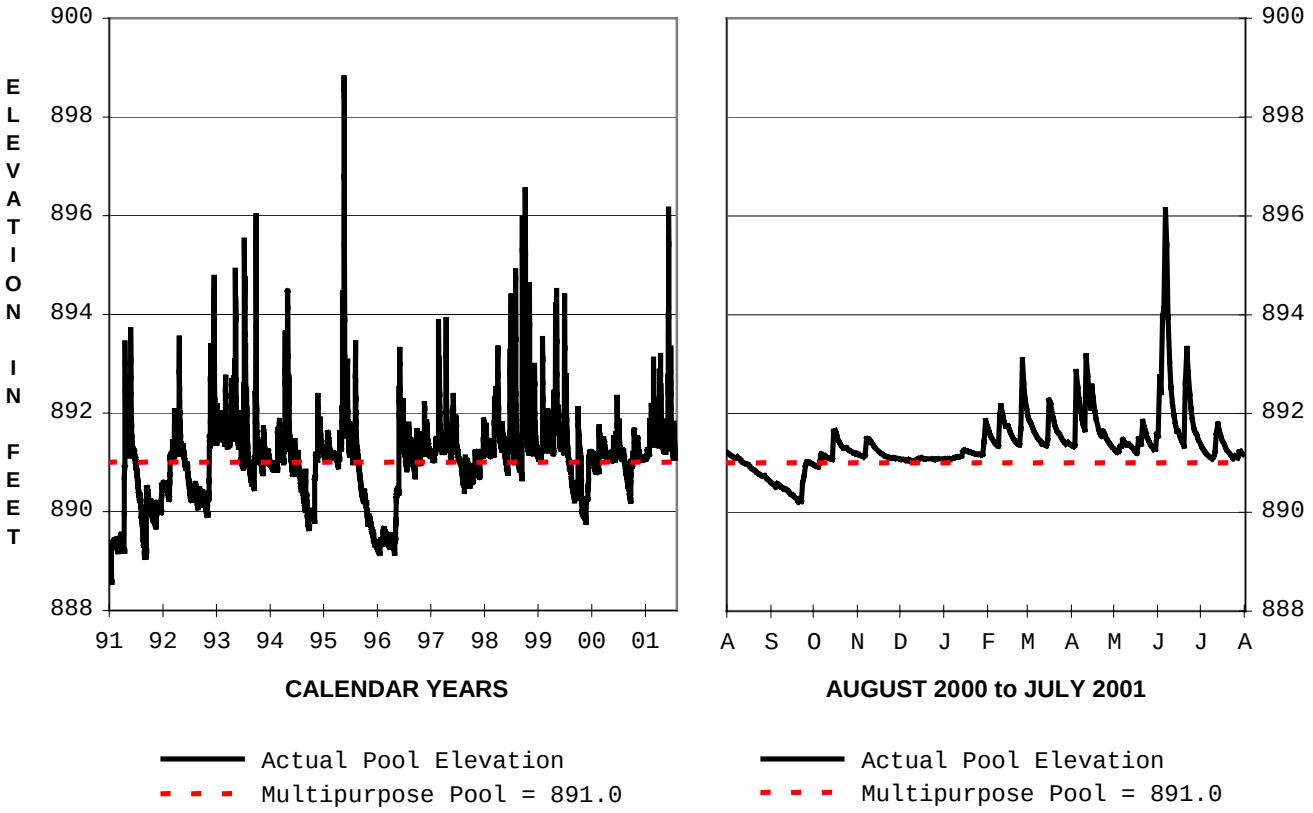



## LONG BRANCH LAKE ANNUAL INFLOW



# LONGVIEW LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

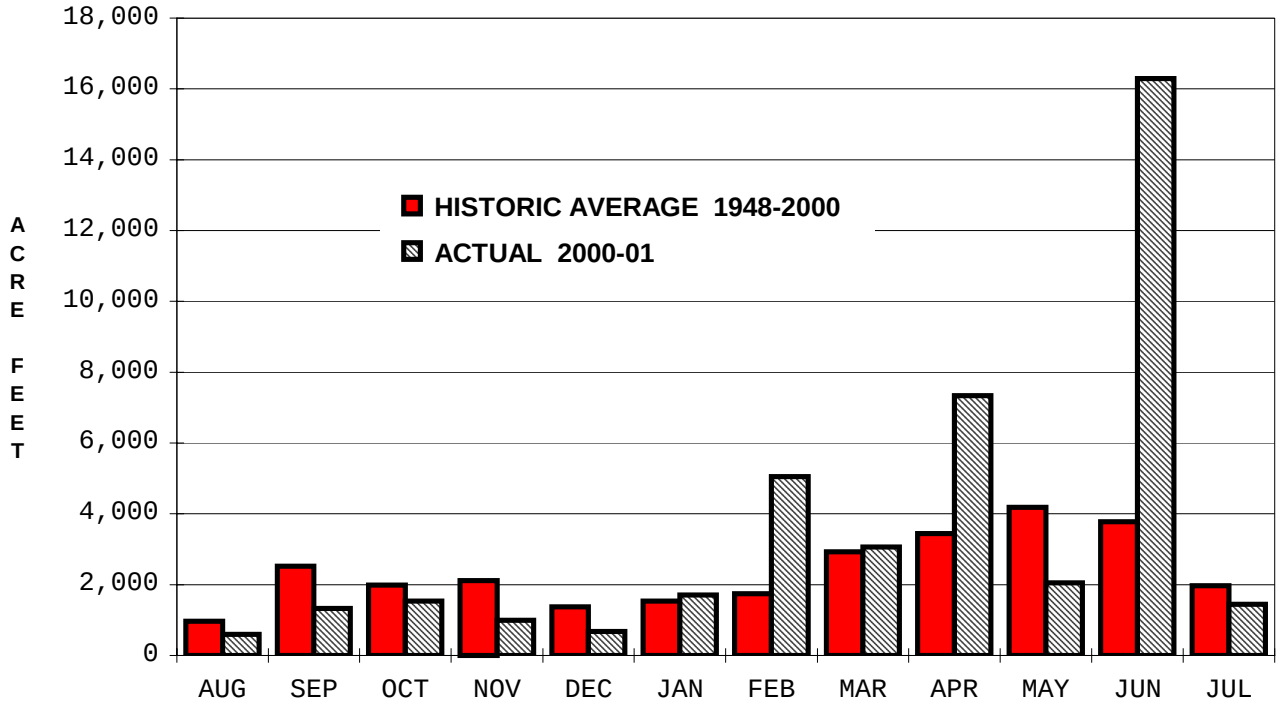



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **891.21<br>1 Aug 00** | **891.17<br>31 Jul 01** | **896.35<br>6 Jun 01** | **890.21<br>20, 22 Sep 00** | **903.37<br>16 May 90** | **888.08<br>14 Sep 88** |

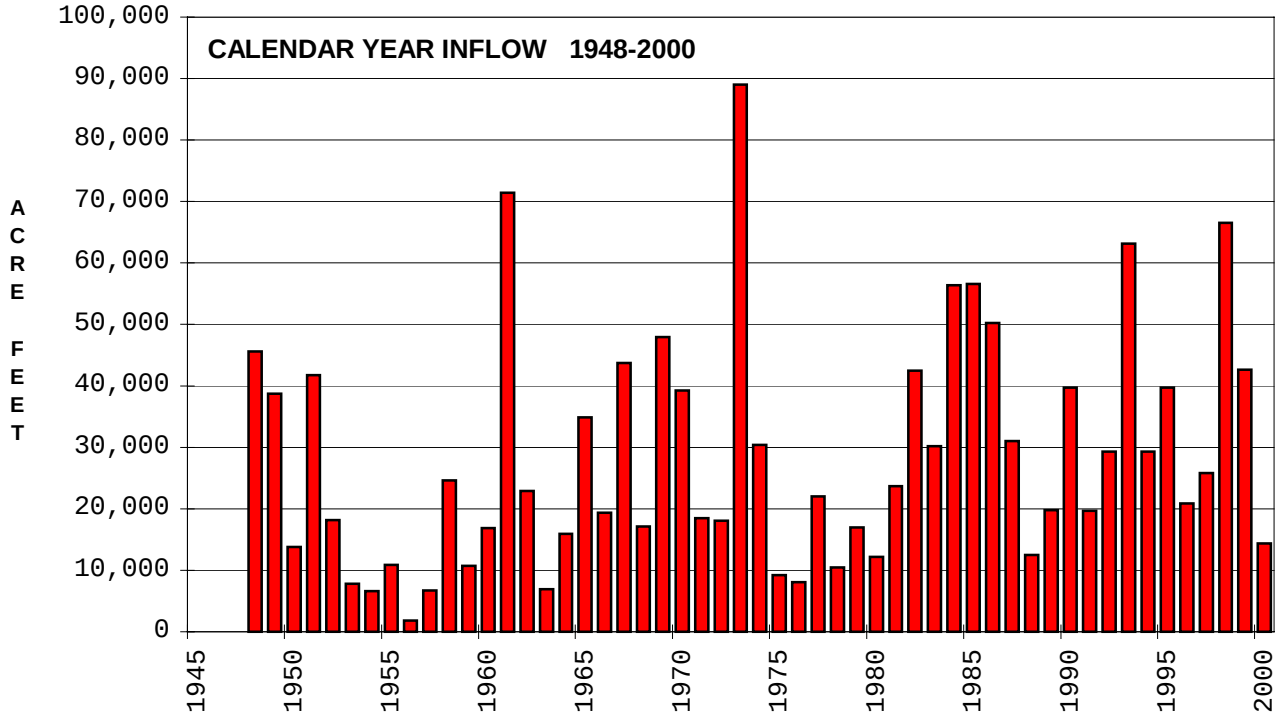
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **1,800<br>4 Jun 01** | **42,070 (88%)<br>15,515 AF previous period** | **1,063<br>7 Jun 01** | **8<br>12 Aug to 5 Oct 00** |

Listed outflows are total to the river from the gate and the uncontrolled notch. Minimum required release is 8 cfs.

## LONGVIEW LAKE MONTHLY INFLOW

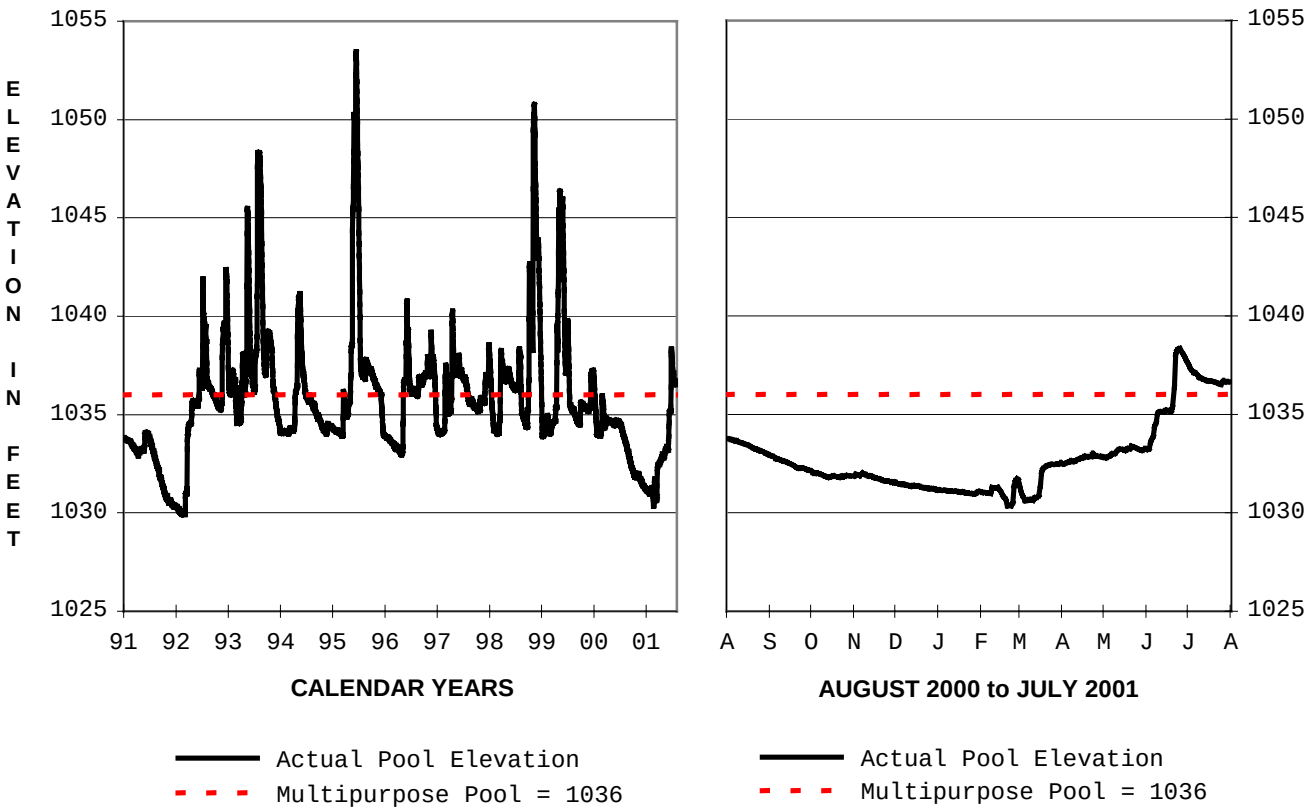



## LONGVIEW LAKE ANNUAL INFLOW



# MELVERN LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

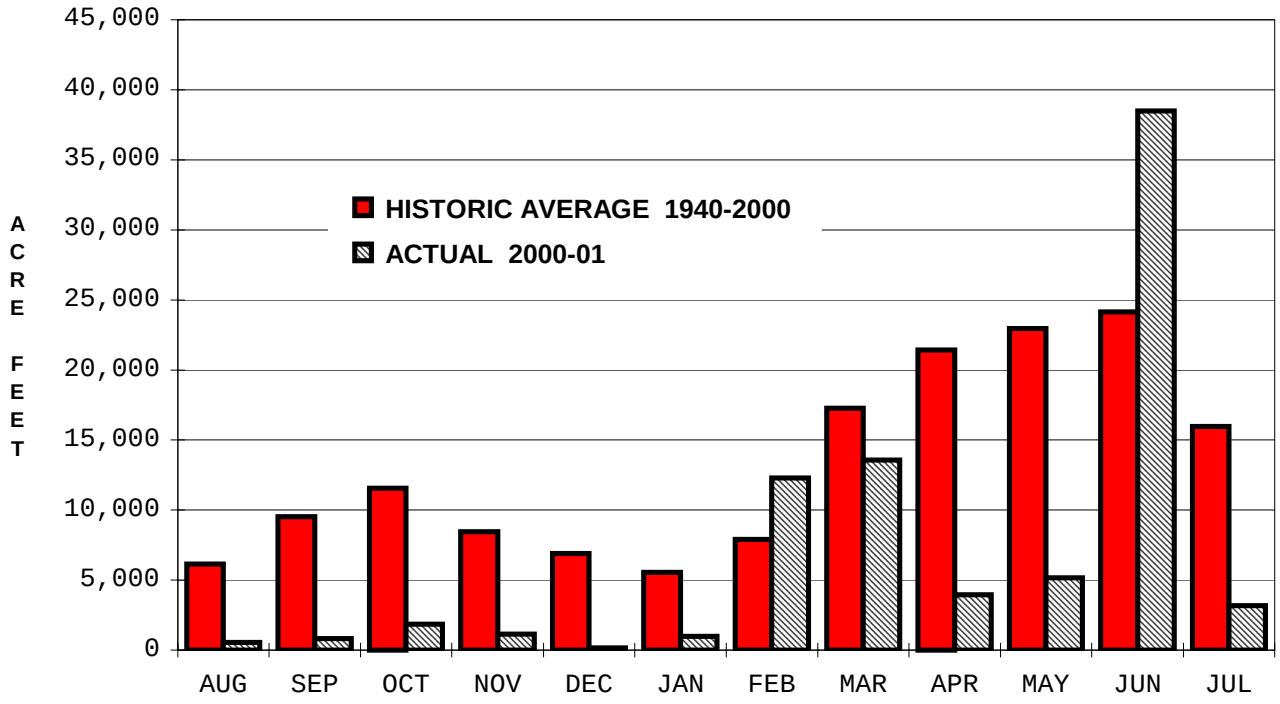



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1033.77<br>1 Aug 00** | **1036.65<br>31 Jul 01** | **1038.35<br>25 Jun 01** | **1030.34<br>21 Feb 01** | **1053.45<br>13 Jun 95** | **1029.87<br>11 Feb 92** |

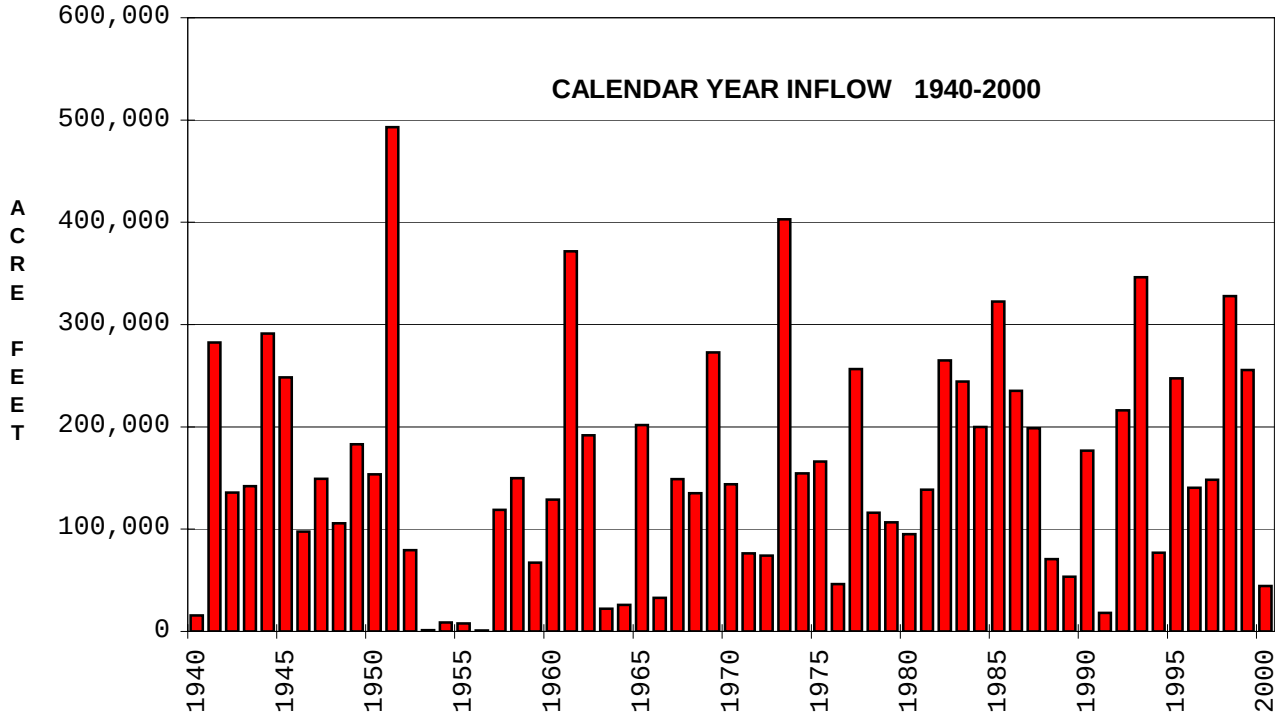
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **6,000<br>22 Jun 01** | **82,194 (52%)<br>73,021 previous period** | **1,000<br>2 Mar 01** | **20<br>Most of the year** |

Listed outflows are to river. Minimum required release is 20 cfs. Releases cut to 0 for short maintenance periods.

## MELVERN LAKE MONTHLY INFLOW

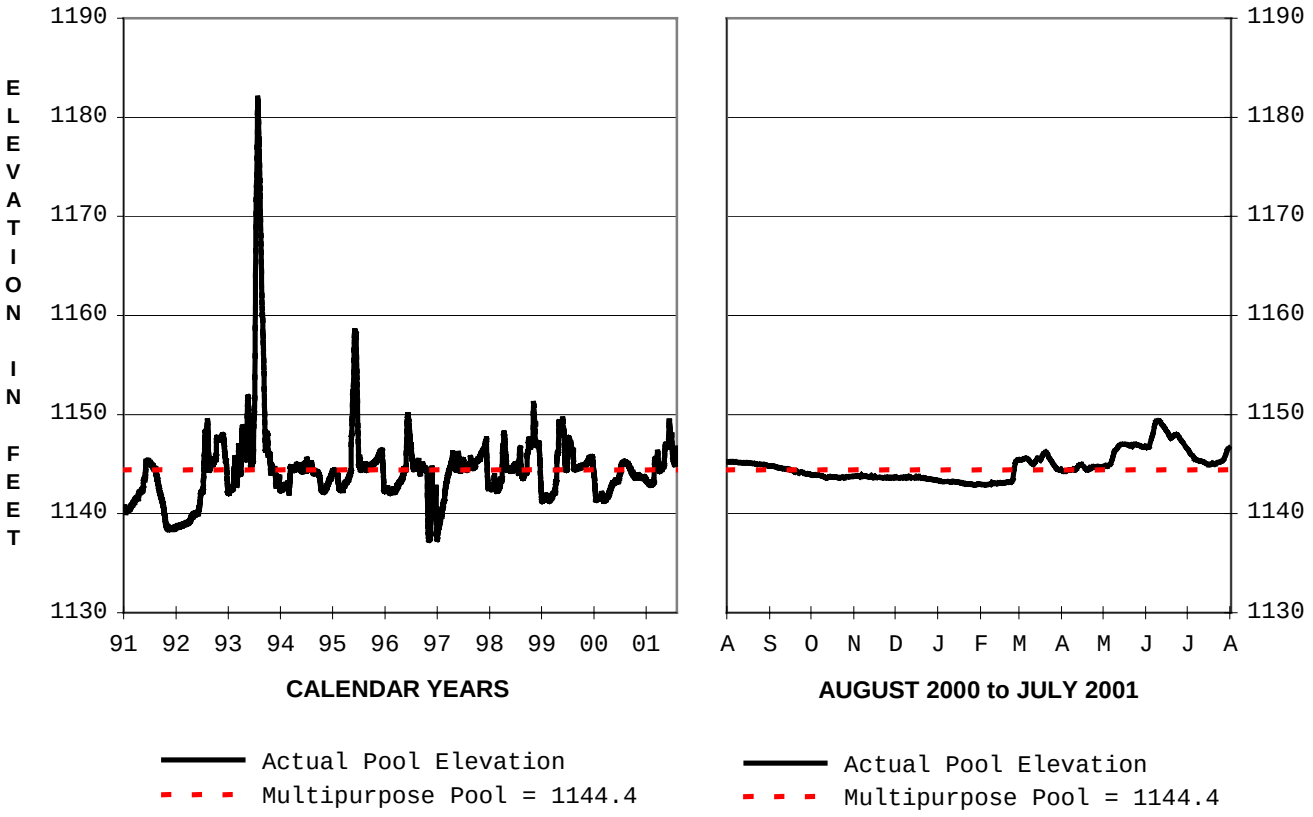



## MELVERN LAKE ANNUAL INFLOW



# MILFORD LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

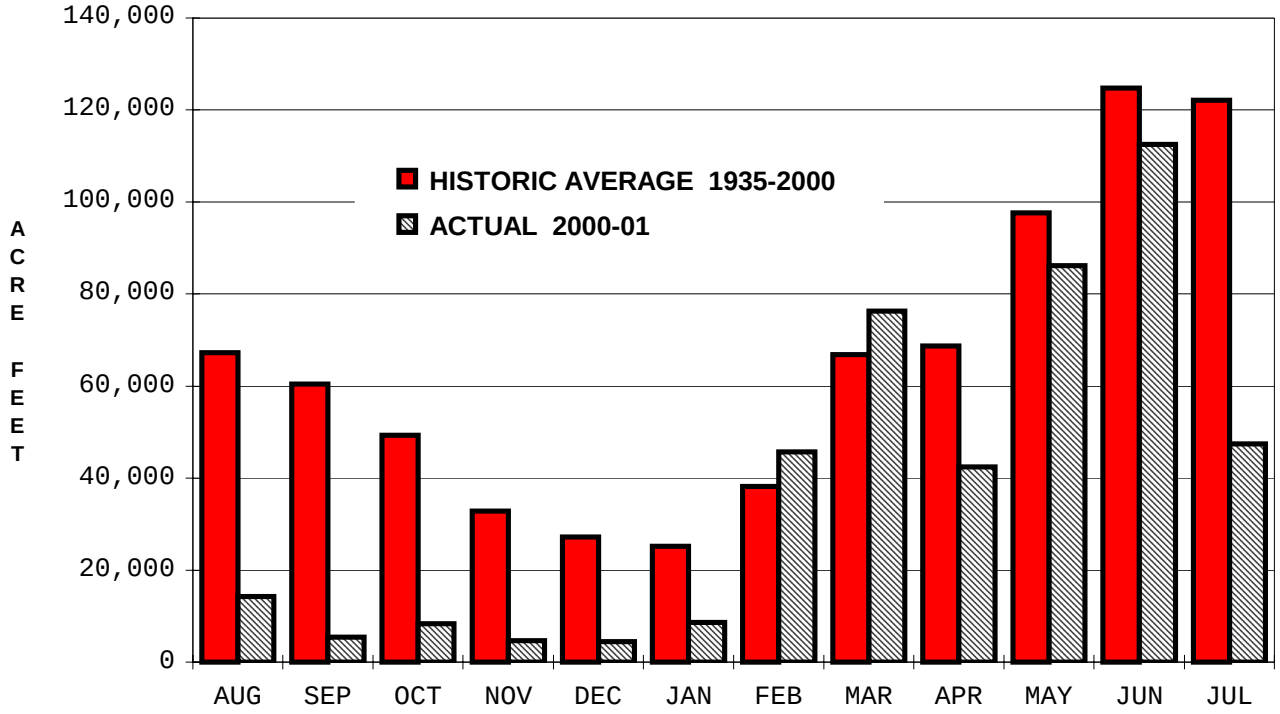



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1145.24<br>1 Aug 00** | **1146.64<br>31 Jul 01** | **1149.35<br>9 Jun 01** | **1142.91<br>28 Jan 01** | **1181.94<br>25 Jul 93** | **1137.30<br>26 Feb 88** |

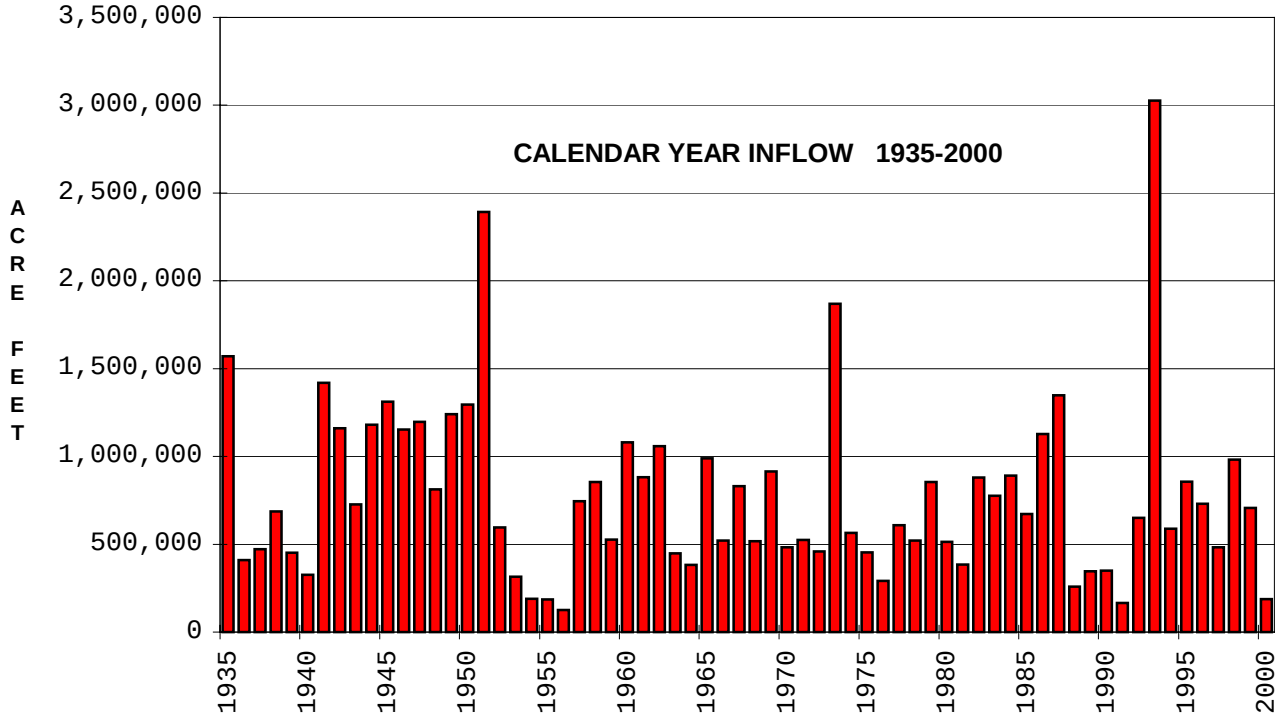
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **8,000<br>25 Feb 01** | **456,384 (59%)<br>260,308 AF previous period** | **3,000 16, 23 Mar 01<br>13-16, 18-20 Jun 01** | **0 5-8 Nov 00, for 5-yr<br>Periodic Inspection** |

All outflows are to the river. Minimum required release is 25 cfs. Releases cut to 0 for short maintenance periods.

## MILFORD LAKE MONTHLY INFLOW

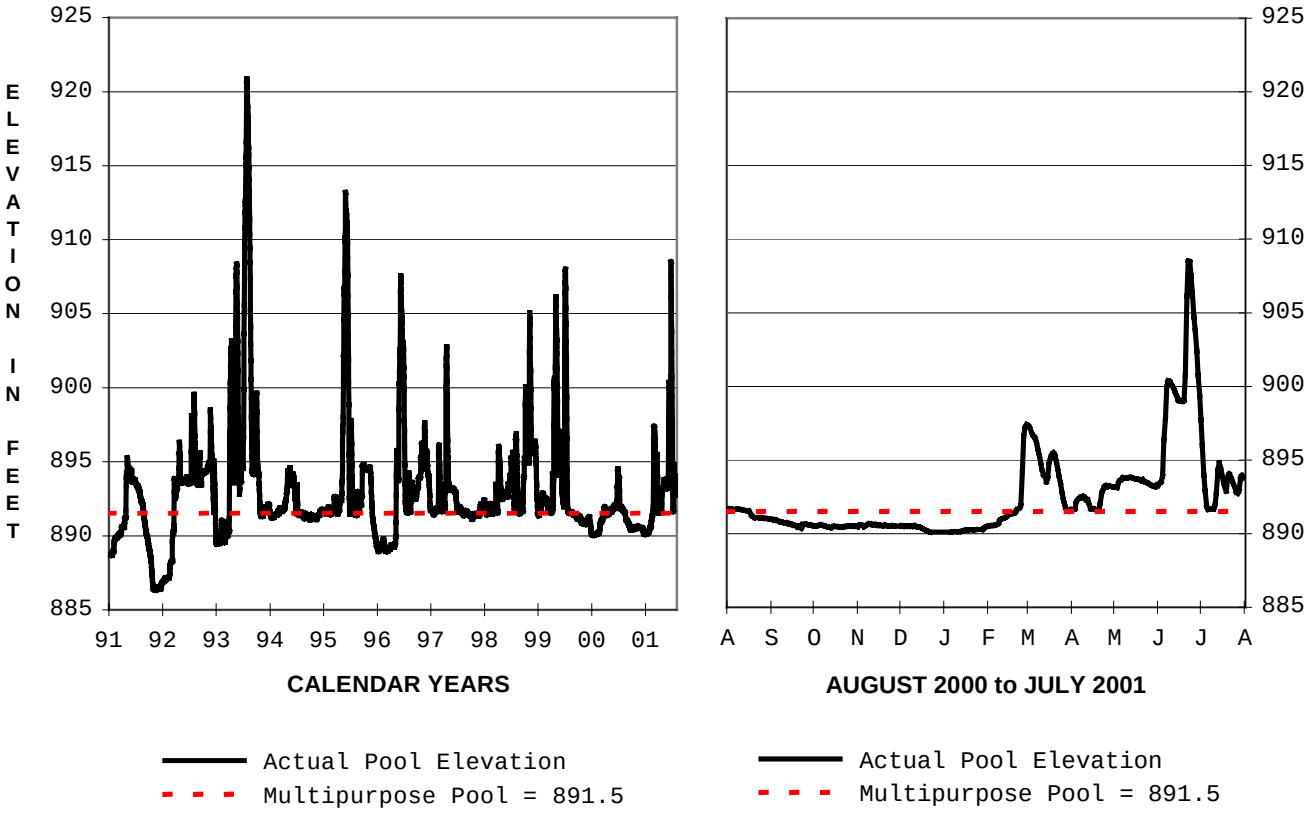



## MILFORD LAKE ANNUAL INFLOW



# PERRY LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

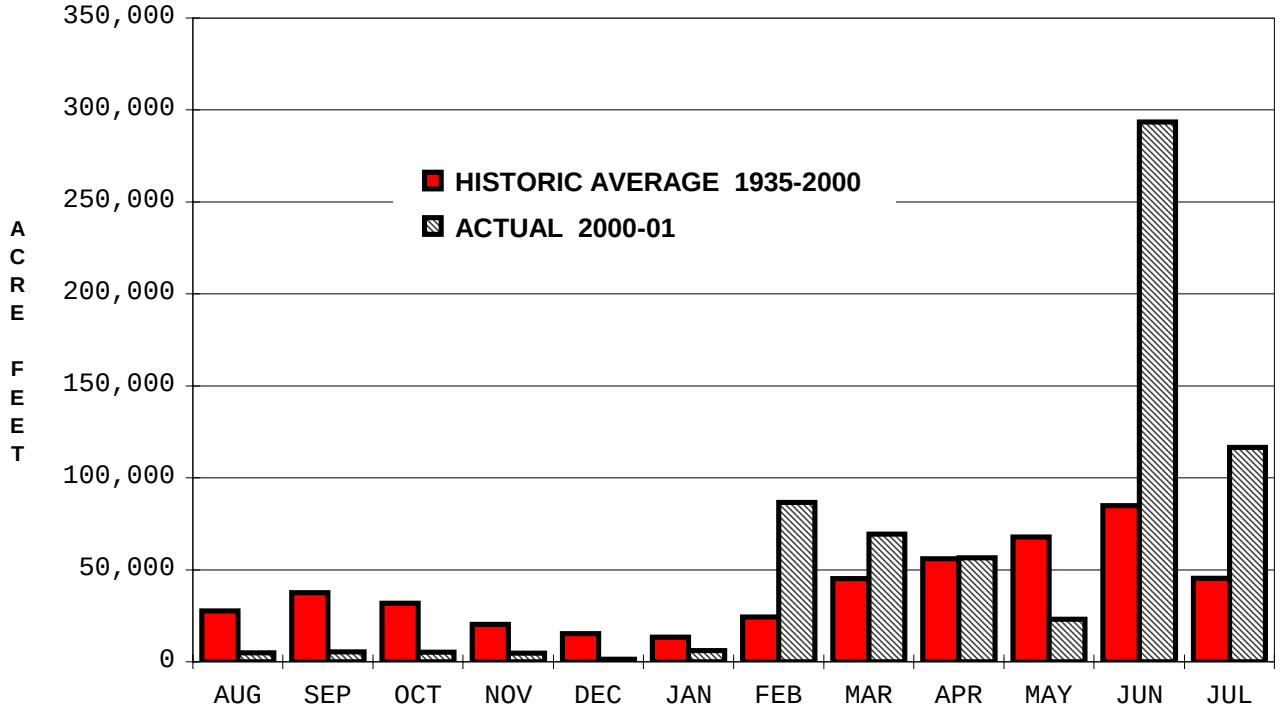



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **891.71<br>1 Aug 00** | **893.75<br>31 Jul 01** | **908.65<br>22 Jun 01** | **890.09<br>22-25 Dec 00** | **920.85<br>25 Jul 93** | **886.22<br>14 Nov 91** |

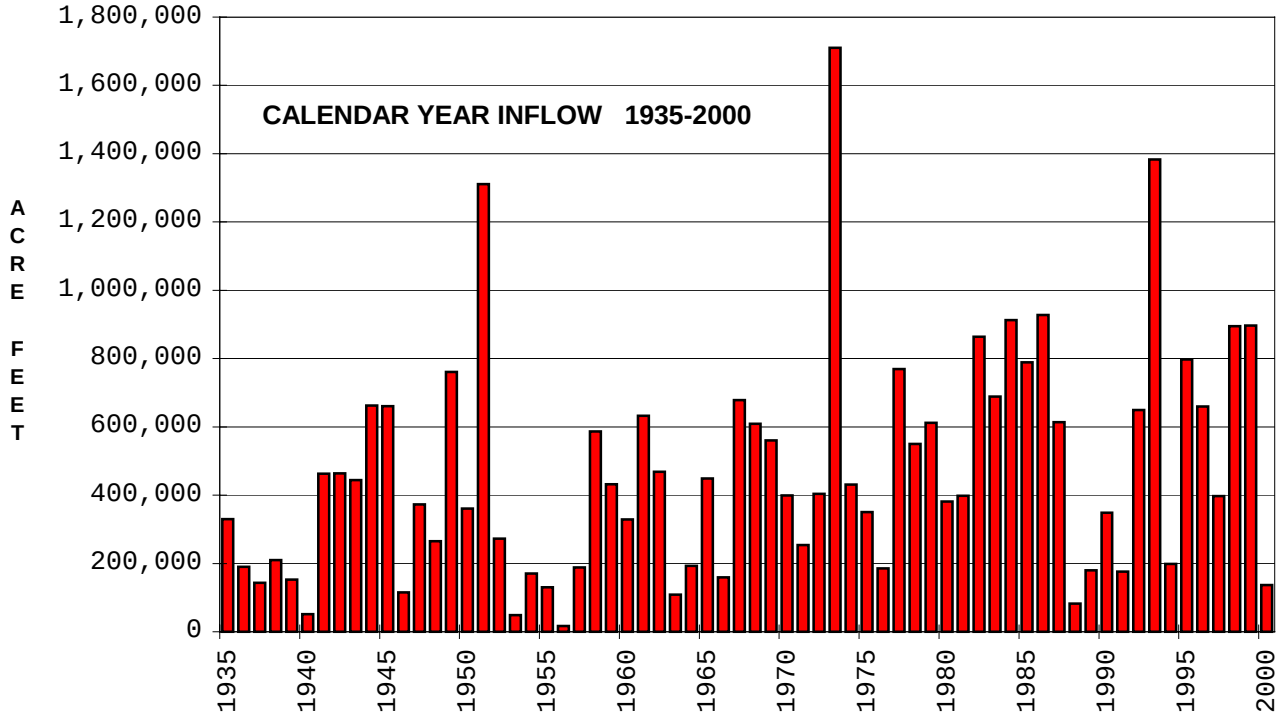
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **45,000<br>21 Jun 01** | **673,478 (142%)<br>143,297 AF previous period** | **12,000<br>25 Jun to 3 Jul 01** | **25<br>Many times** |

All outflows are to the river. Minimum required release is 25 cfs. Releases cut to 0 for short maintenance periods.

## PERRY LAKE MONTHLY INFLOW

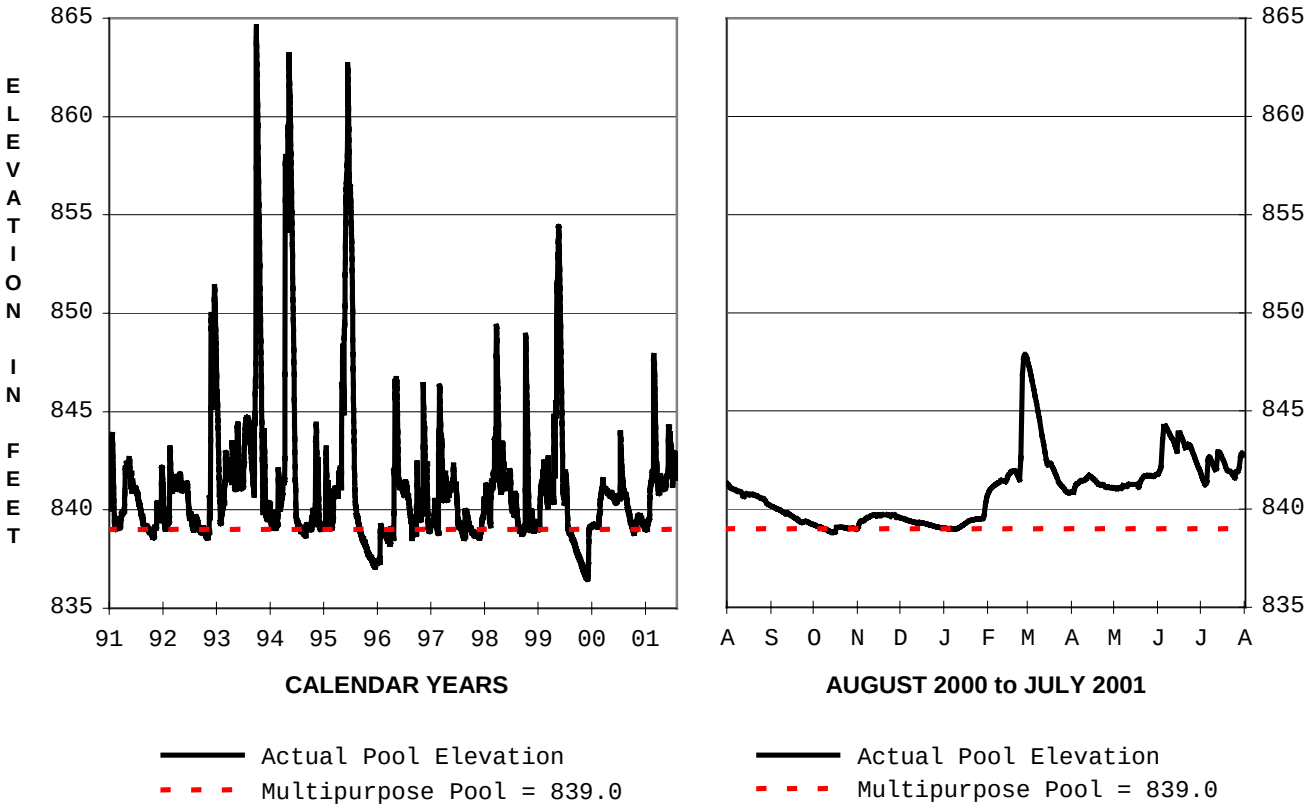



## PERRY LAKE ANNUAL INFLOW



# POMME DE TERRE LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

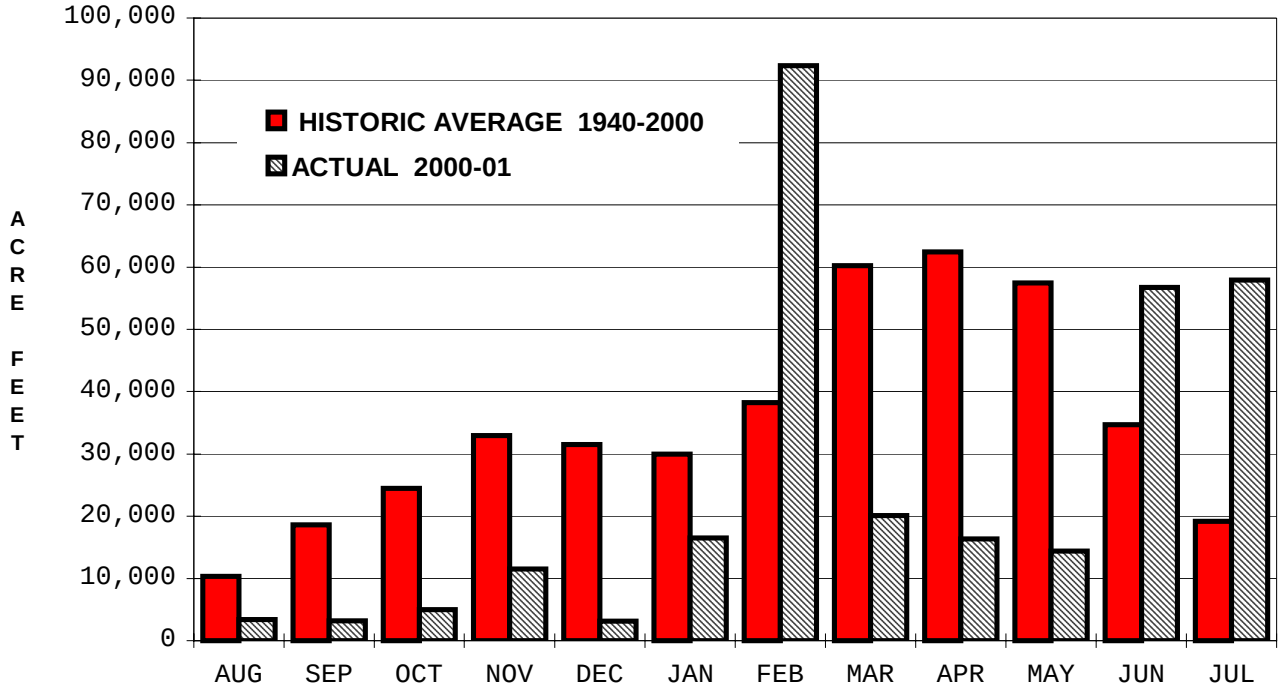



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **841.31<br>1 Aug 00** | **842.74<br>31 Jul 01** | **847.86<br>27 Feb 01** | **838.81<br>14 Oct 00** | **864.58<br>27 Sep 93** | **835.61<br>3 Mar 64** |

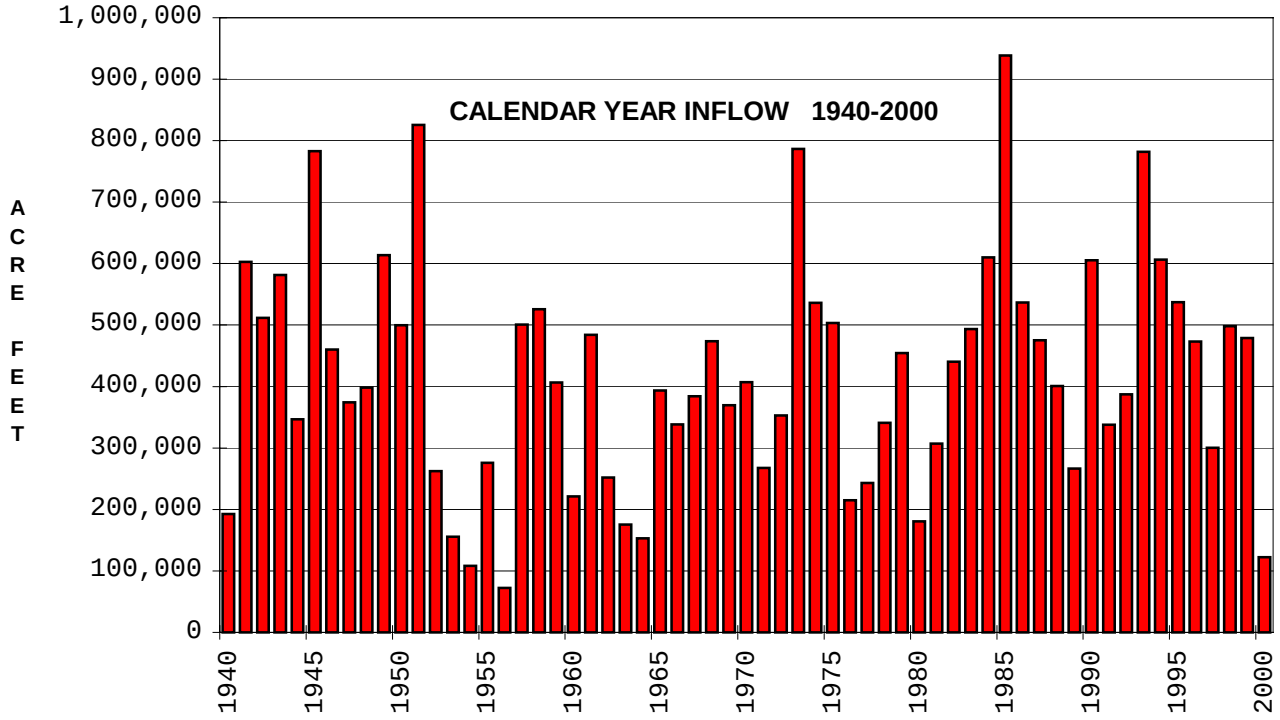
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **20,000<br>25 Feb 01** | **300,034 (72%)<br>130,106 AF previous period** | **2,000<br>1-14 Mar 01** | **50<br>Most of Oct thru Jan** |

All outflows are to the river. Minimum required release is 50 to 100 cfs, varying by season and pool level.

## POMME DE TERRE LAKE MONTHLY INFLOW

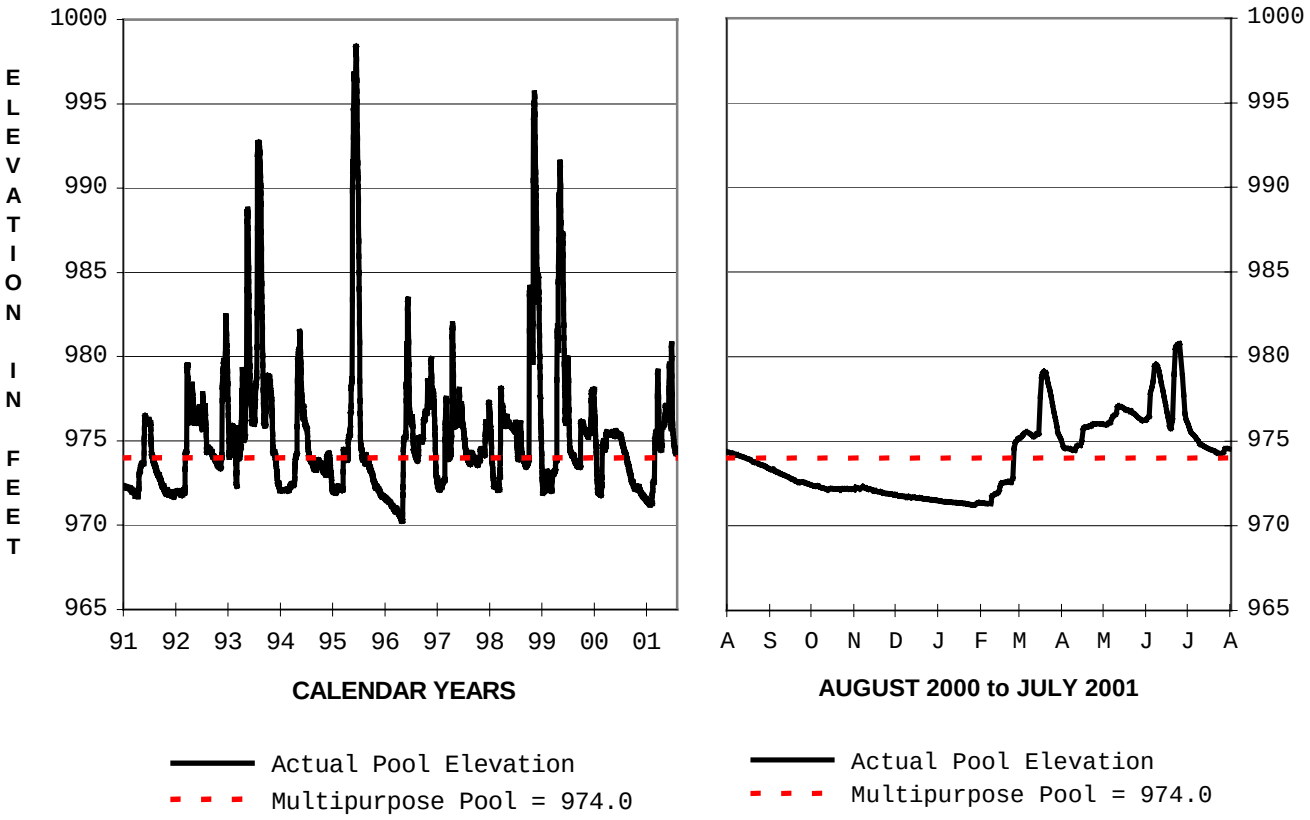



## POMME DE TERRE LAKE ANNUAL INFLOW



# POMONA LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

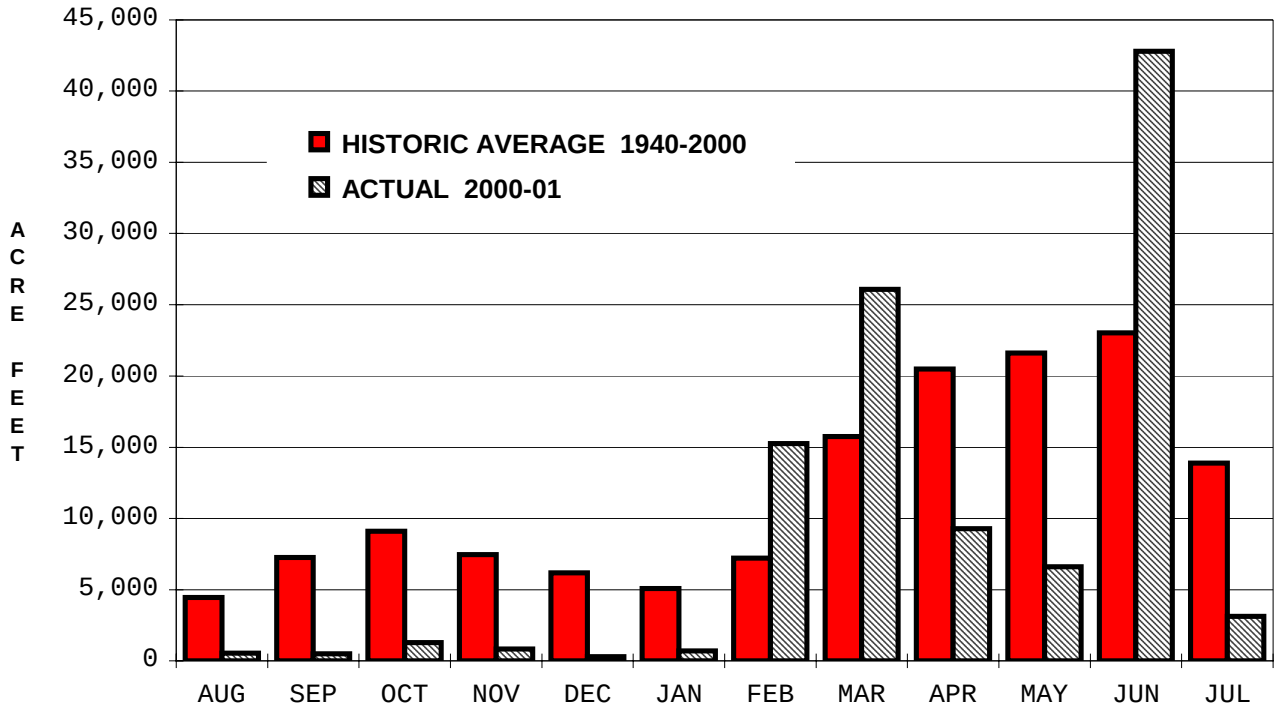



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **974.37<br>1 Aug 00** | **974.53<br>31 Jul 01** | **980.78<br>25 Jun 01** | **971.22<br>27 Jan 01** | **998.40<br>12-13 Jun 95** | **969.62<br>30 Mar 67** |

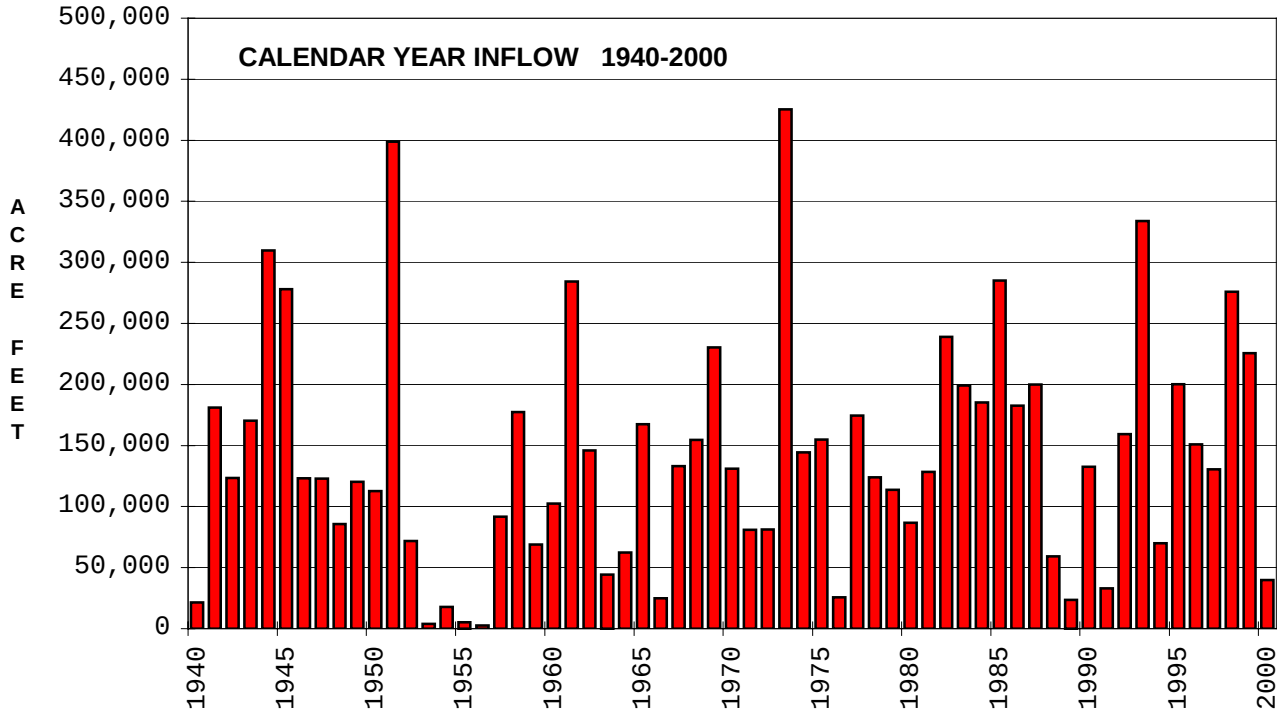
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **6,000<br>21 Jun 01** | **107,315 (76%)<br>65,068 AF previous period** | **2,500<br>27-29 Jun 01** | **15<br>Most of the year** |

All outflows are to the river. Minimum required release is 15 cfs. Releases cut to 0 for short maintenance periods.

## POMONA LAKE MONTHLY INFLOW

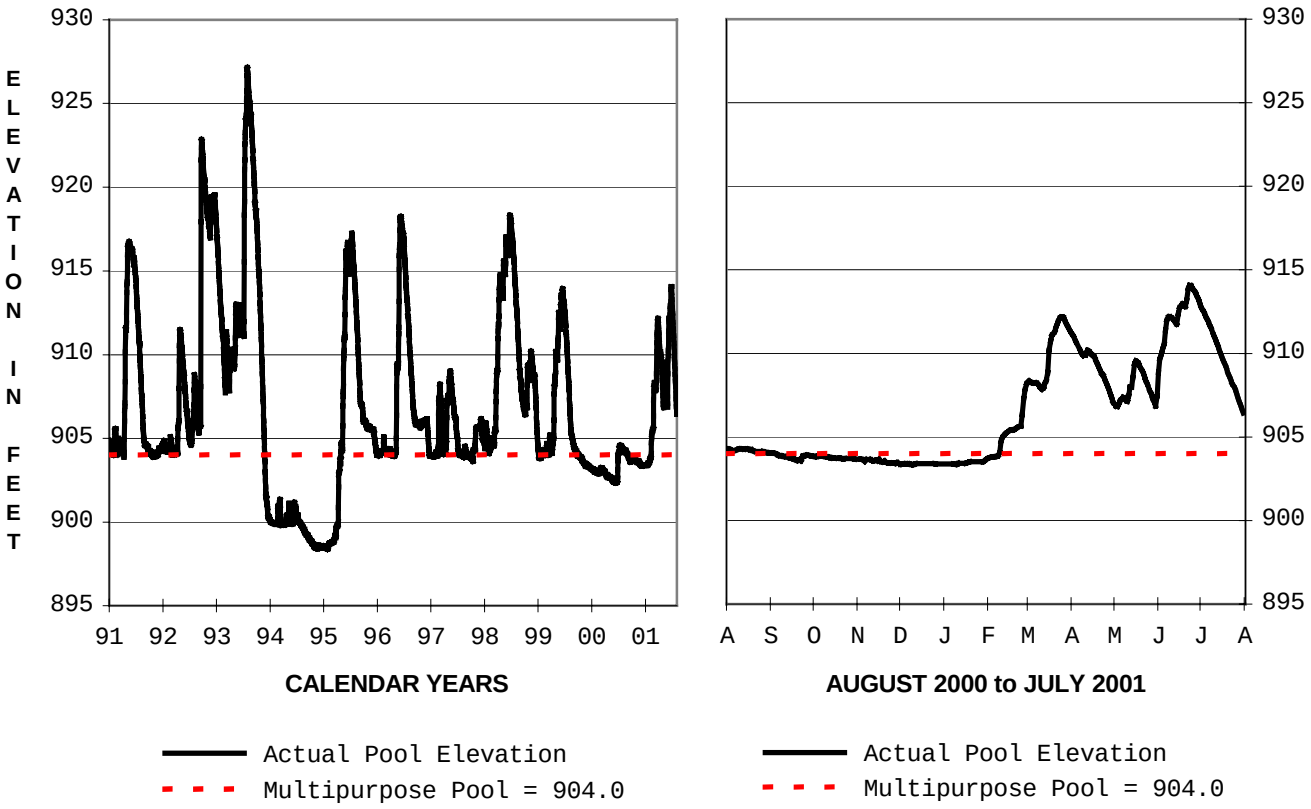



## POMOMA LAKE ANNUAL INFLOW



# RATHBUN LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

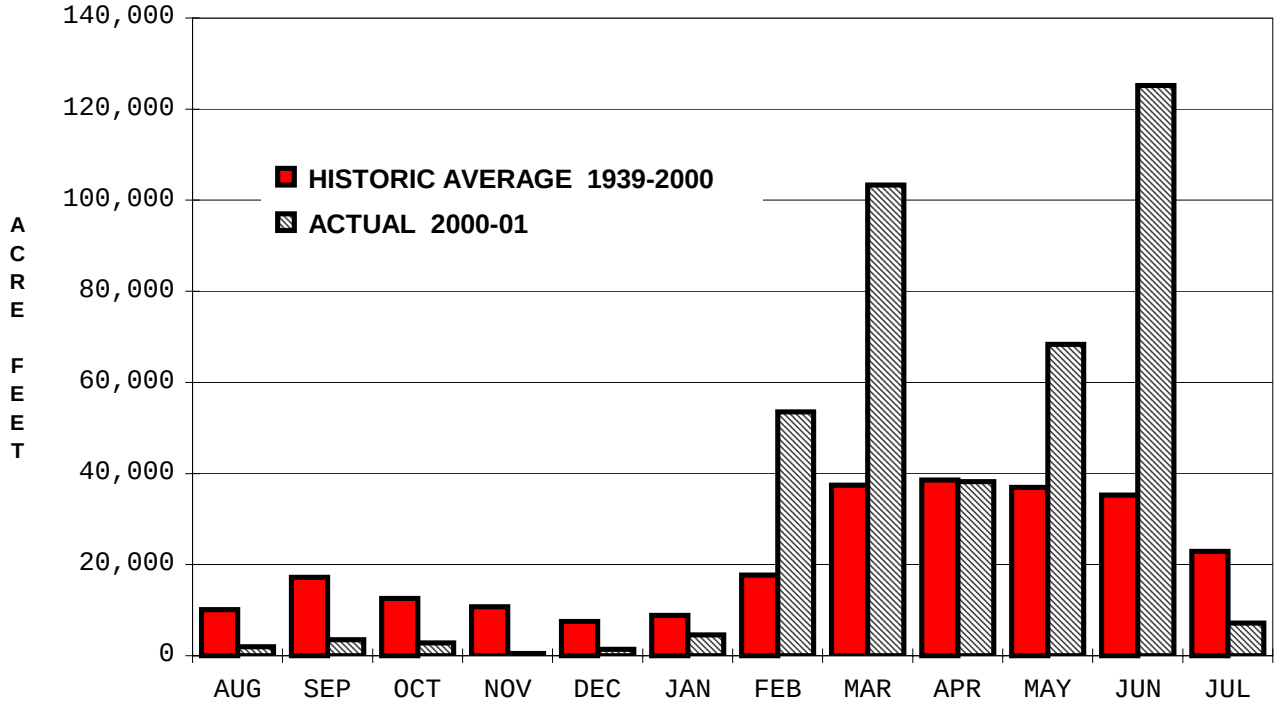



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **904.32<br>1 Aug 00** | **906.43<br>31 Jul 01** | **914.07<br>23 Jun 01** | **903.34<br>9 Dec 00** | **927.16<br>28 Jul 93** | **898.38<br>26-27 Jan 95** |

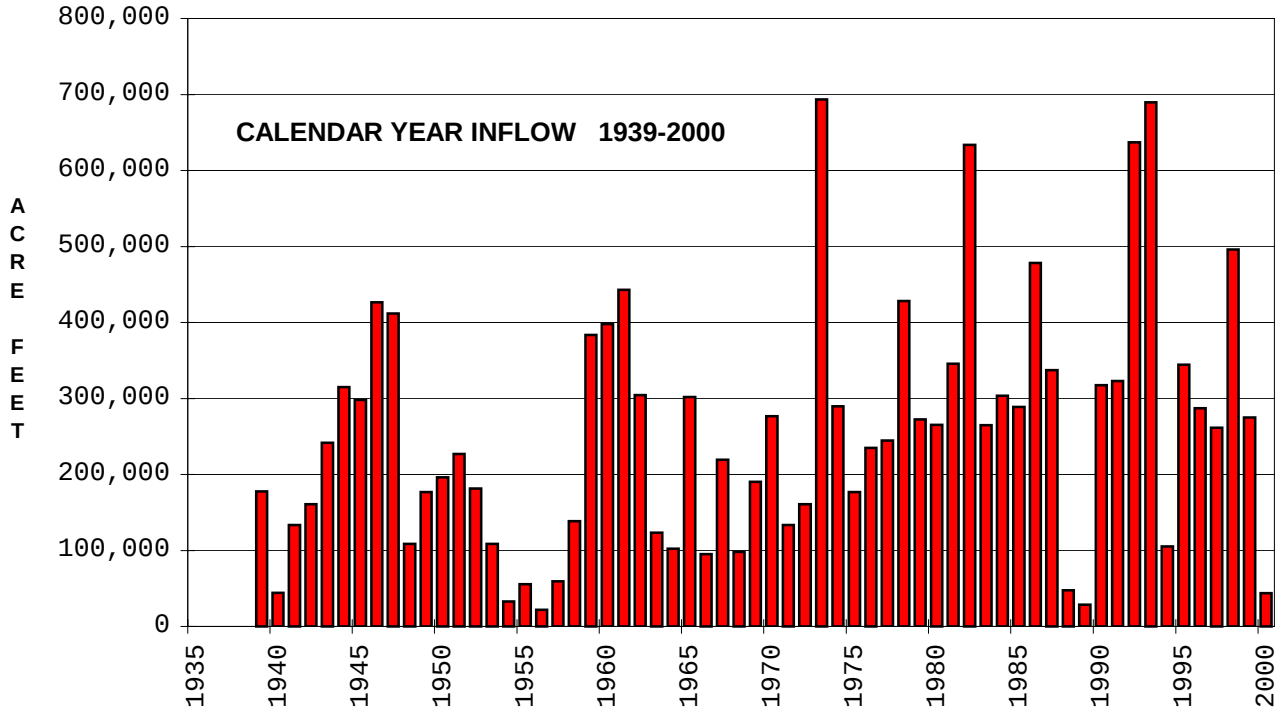
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **9,000<br>1 Jun 01** | **410,537 (159%)<br>40,849 AF previous period** | **1,507 Many days<br>March thru July 01** | **7 24-27 Oct 00 for<br>Periodic Inspection** |

All outflows to the river. Outlets include a fish hatchery pipe and service gate. Minimum release varies 15-30 cfs.

## RATHBUN LAKE MONTHLY INFLOW

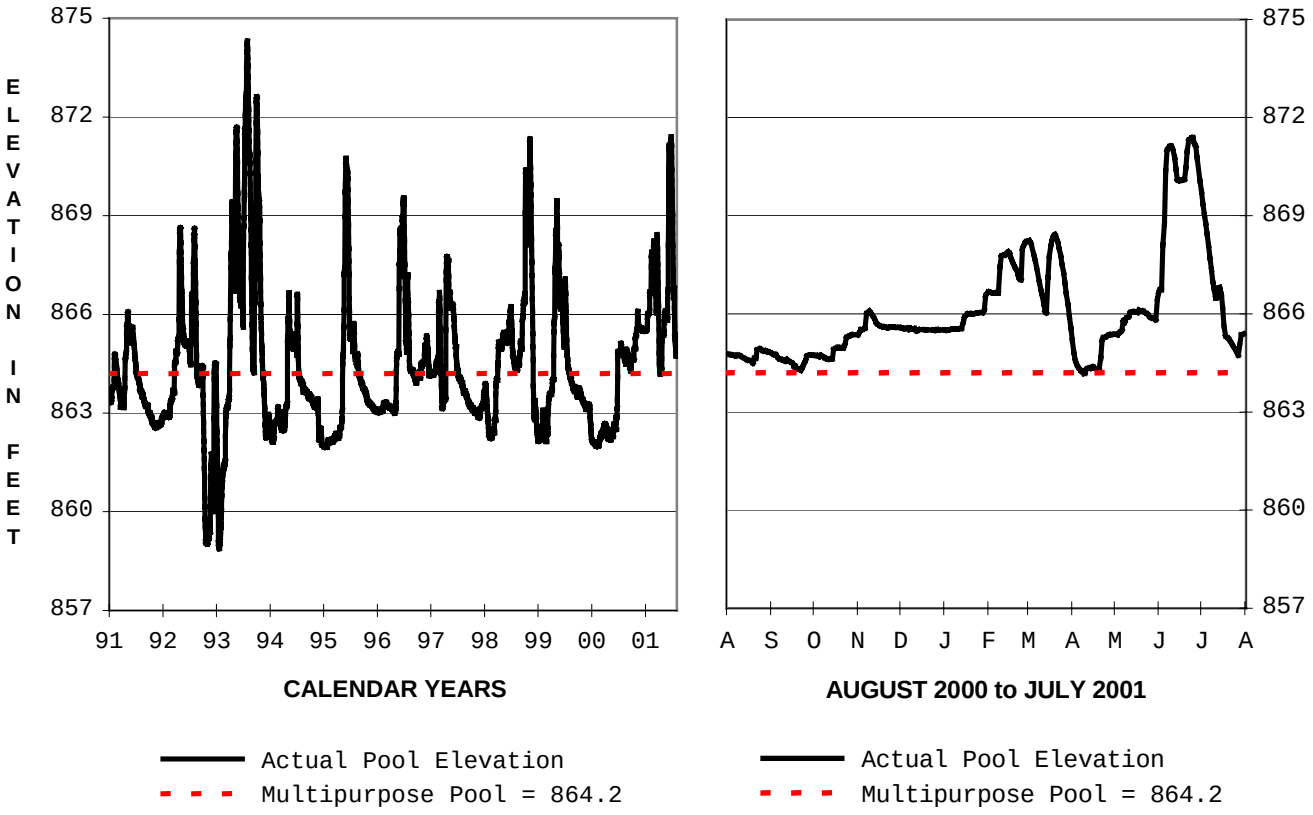



## RATHBUN LAKE ANNUAL INFLOW



# SMITHVILLE LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

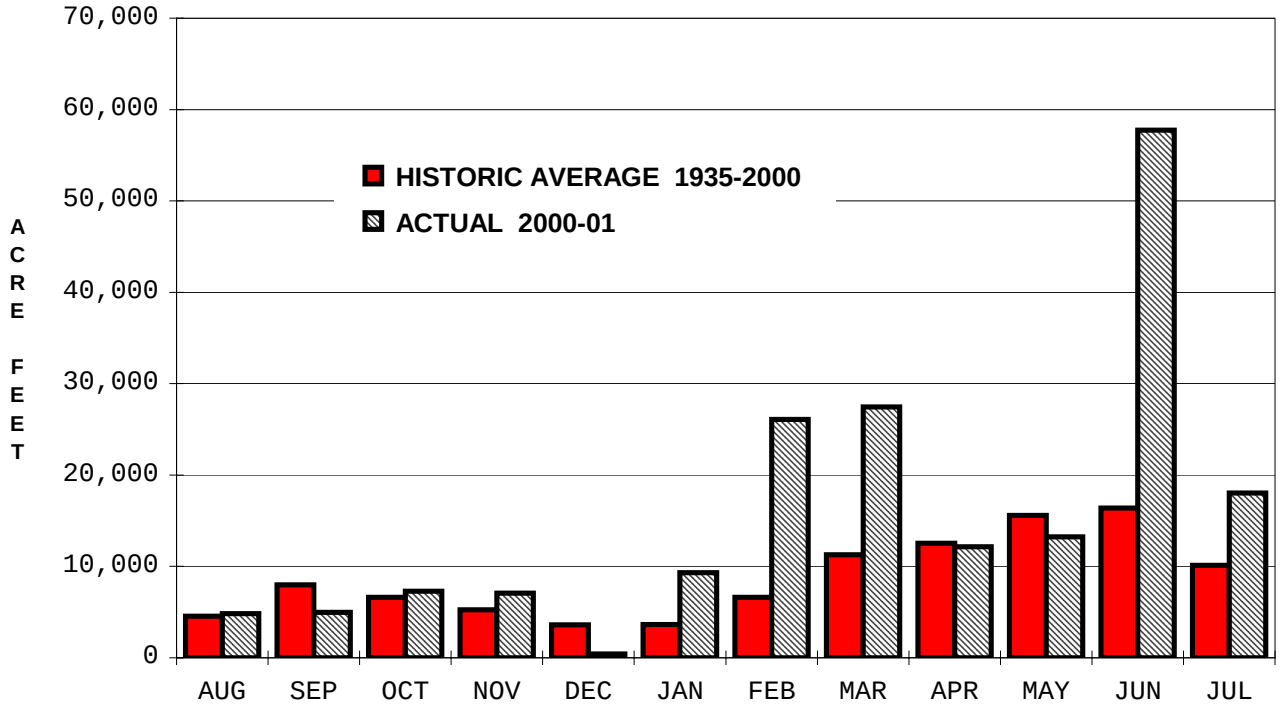



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **864.79<br>1 Aug 00** | **865.40<br>31 Jul 01** | **871.39<br>24-25 Jun 01** | **864.18<br>9-10 Apr 01** | **874.31<br>27-28 Jul 93** | **858.86<br>19 Jan 93** |

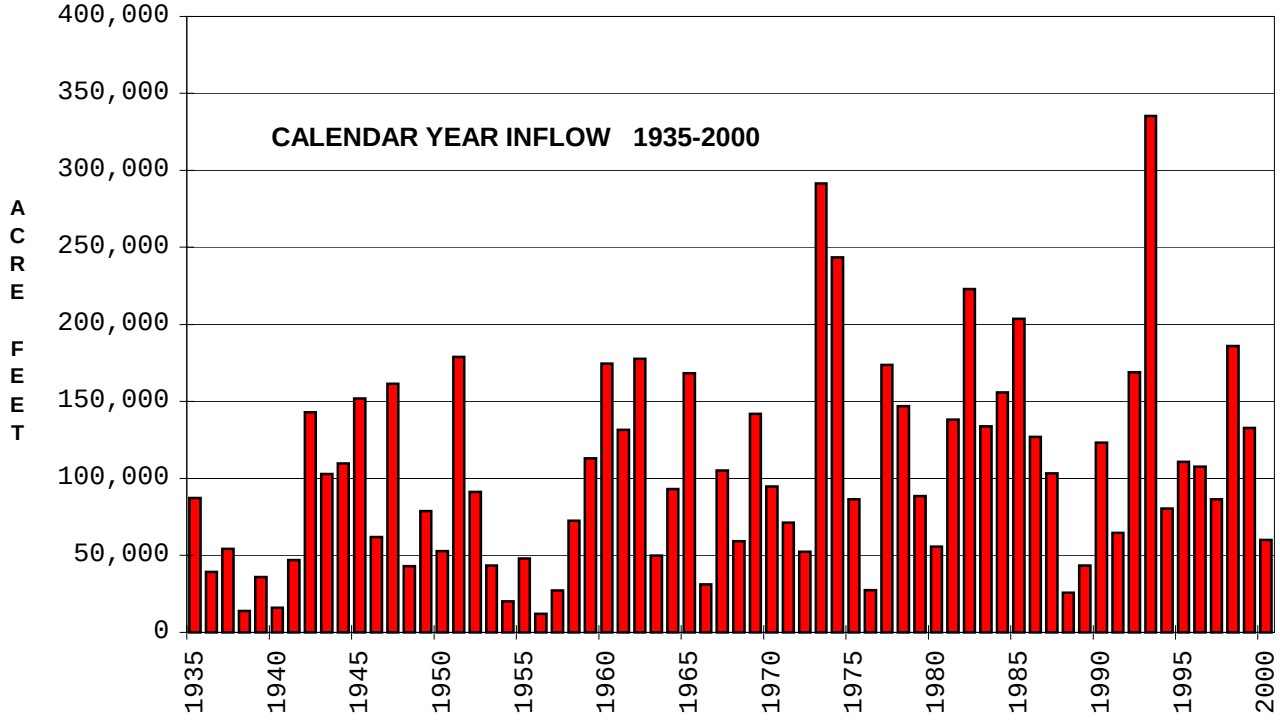
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **6,900<br>6 Jun 01** | **187,623 (181%)<br>43,397 AF previous period** | **1,500 Many times<br>28 Mar thru 16 Jul 01** | **0<br>Many times.** |

Listed outflows are to river. Min required release is 8 cfs. Releases cut to 0 during flooding and for maintenance.

## SMITHVILLE LAKE MONTHLY INFLOW

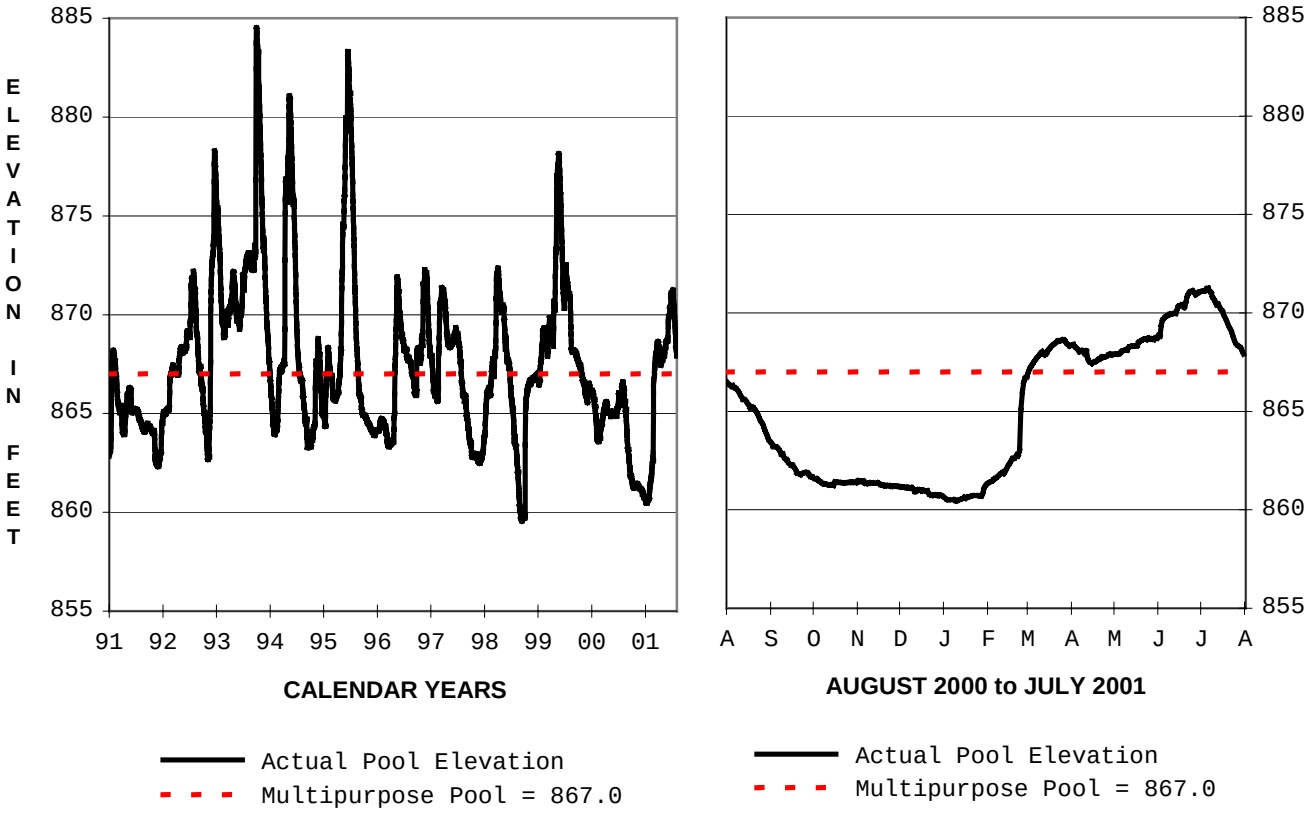



## SMITHVILLE LAKE ANNUAL INFLOW



# STOCKTON LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

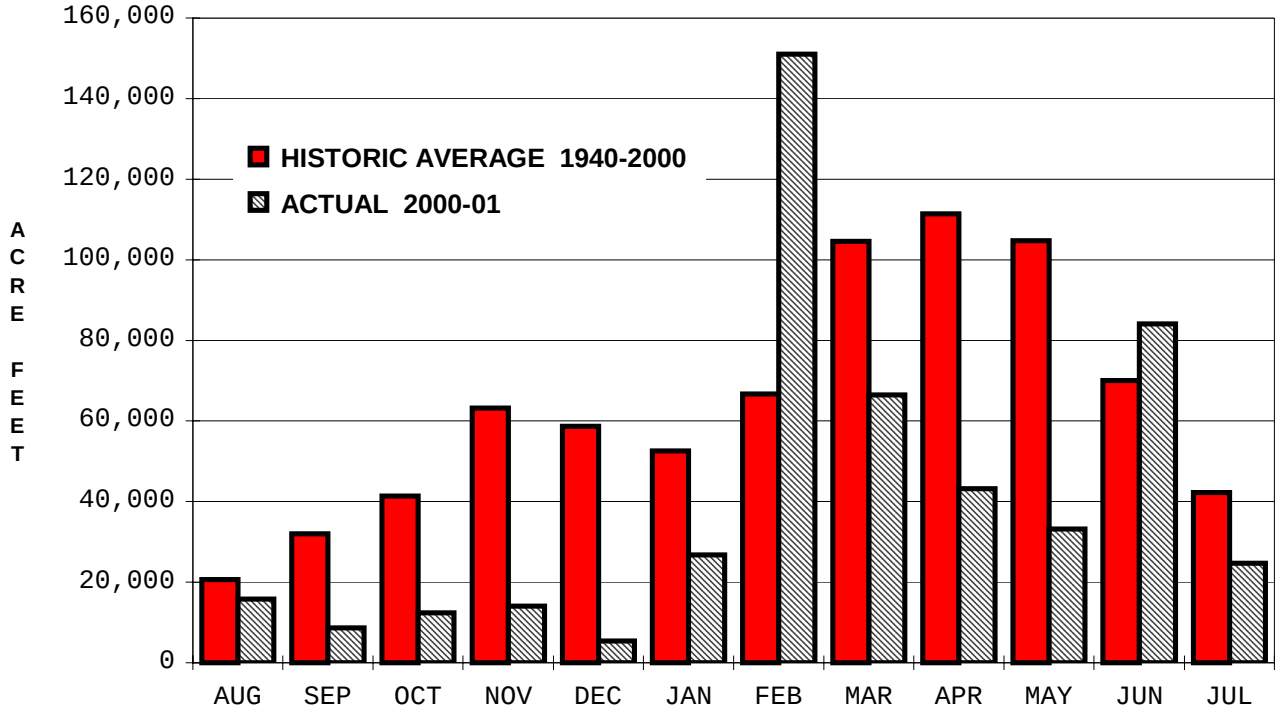



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **866.49<br>1 Aug 00** | **867.90<br>31 Jul 01** | **871.27<br>7 Jul 01** | **860.44<br>9 Jan 01** | **885.94<br>28 Apr 73** | **851.86<br>2 Feb 77** |

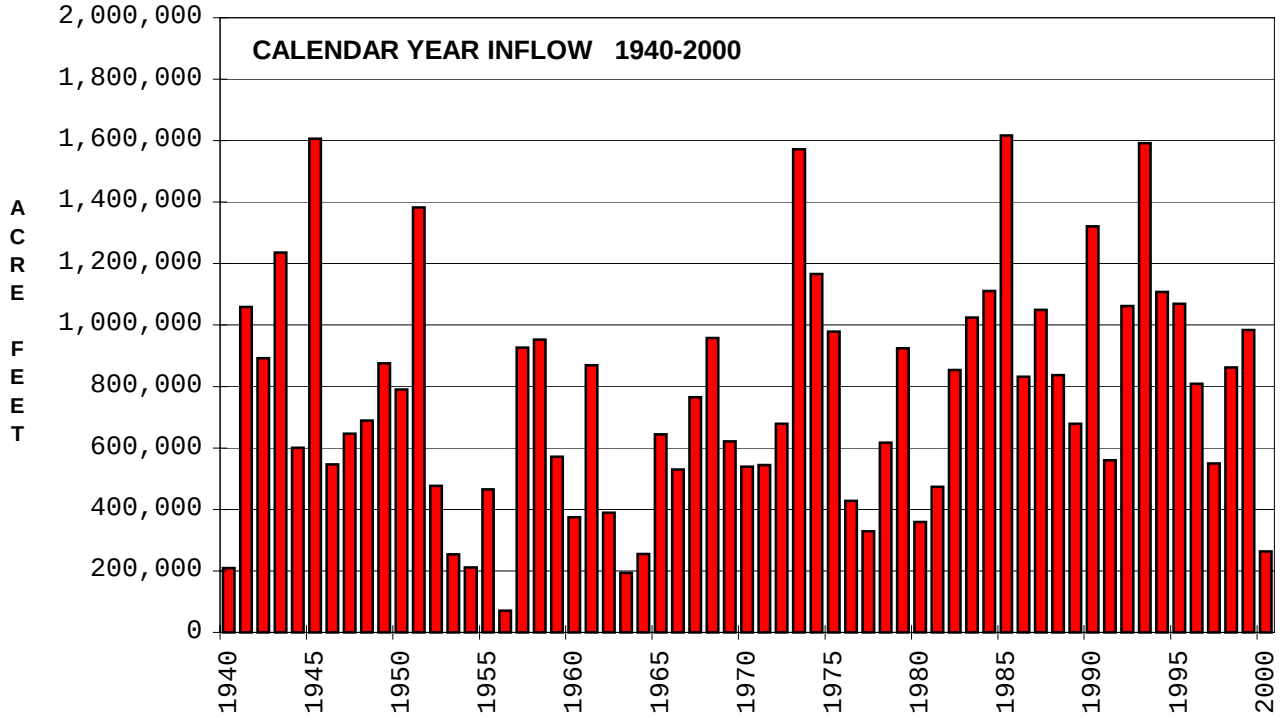
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **25,000<br>24 Feb 01** | **485,561 (63%)<br>280,020 AF previous period** | **3,110<br>28 Feb 01** | **40<br>Frequently** |

Listed outflows include turbine releases and spill to the river. 40 cfs spill required when not generating.

## STOCKTON LAKE MONTHLY INFLOW

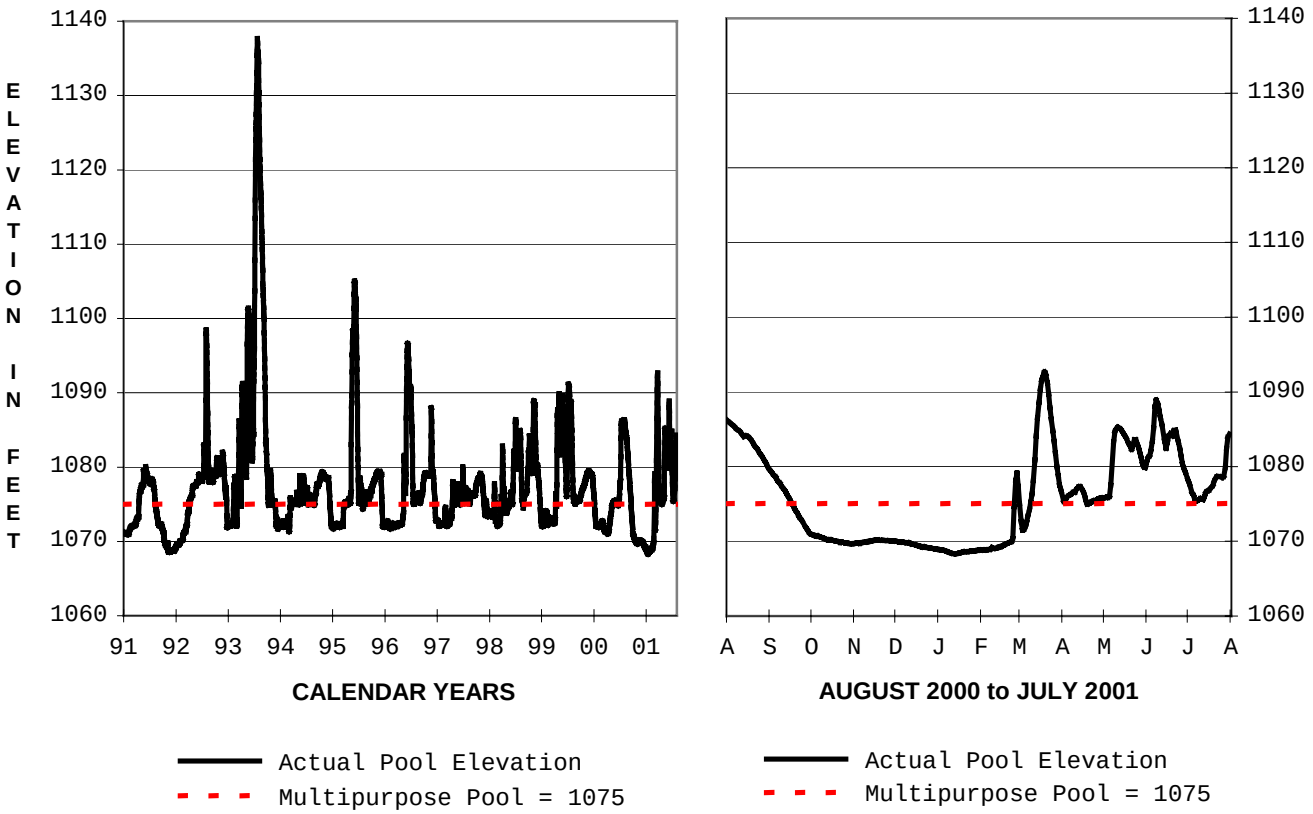



## STOCKTON LAKE ANNUAL INFLOW



# TUTTLE CREEK LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

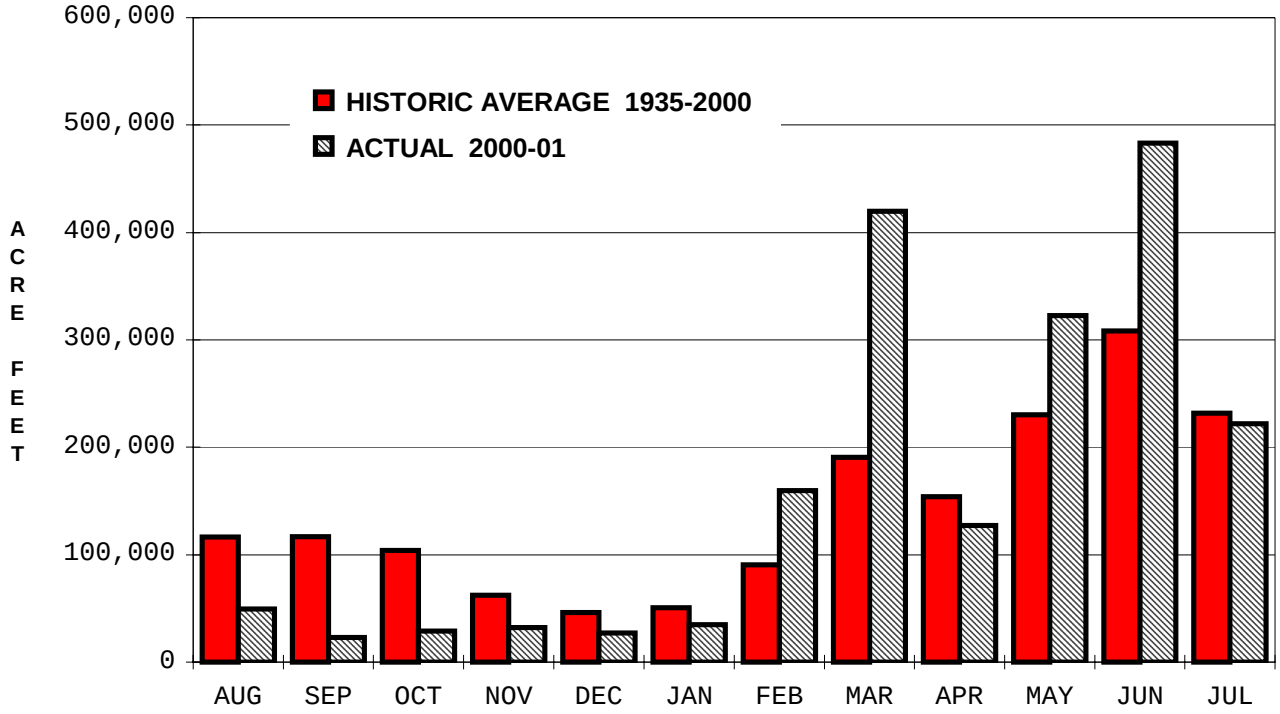



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1086.23<br>1 Aug 00** | **1084.33<br>31 Jul 01** | **1092.73<br>19 Mar 01** | **1068.33<br>12-13 Jan 01** | **1137.77<br>22 Jul 93** | **1060.82<br>4 Jan 67** |

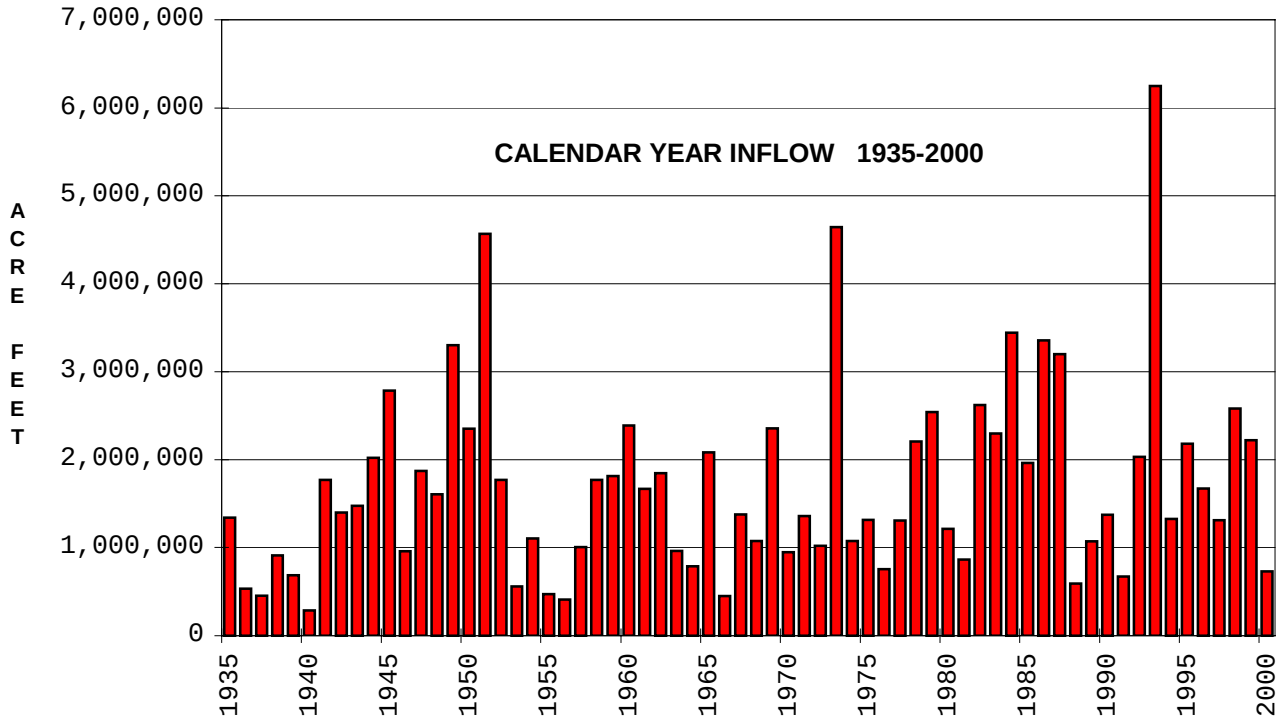
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **29,000<br>7 Jun 01** | **1,929,797 (113%)<br>879,835 AF previous period** | **21,000<br>23 Mar 01** | **0 8-16 Mar 01 for Periodic Inspection** |

All outflows are to the river. Minimum release is 50 to 100 cfs. Releases cut to 0 for short maintenance periods.

## TUTTLE CREEK LAKE MONTHLY INFLOW

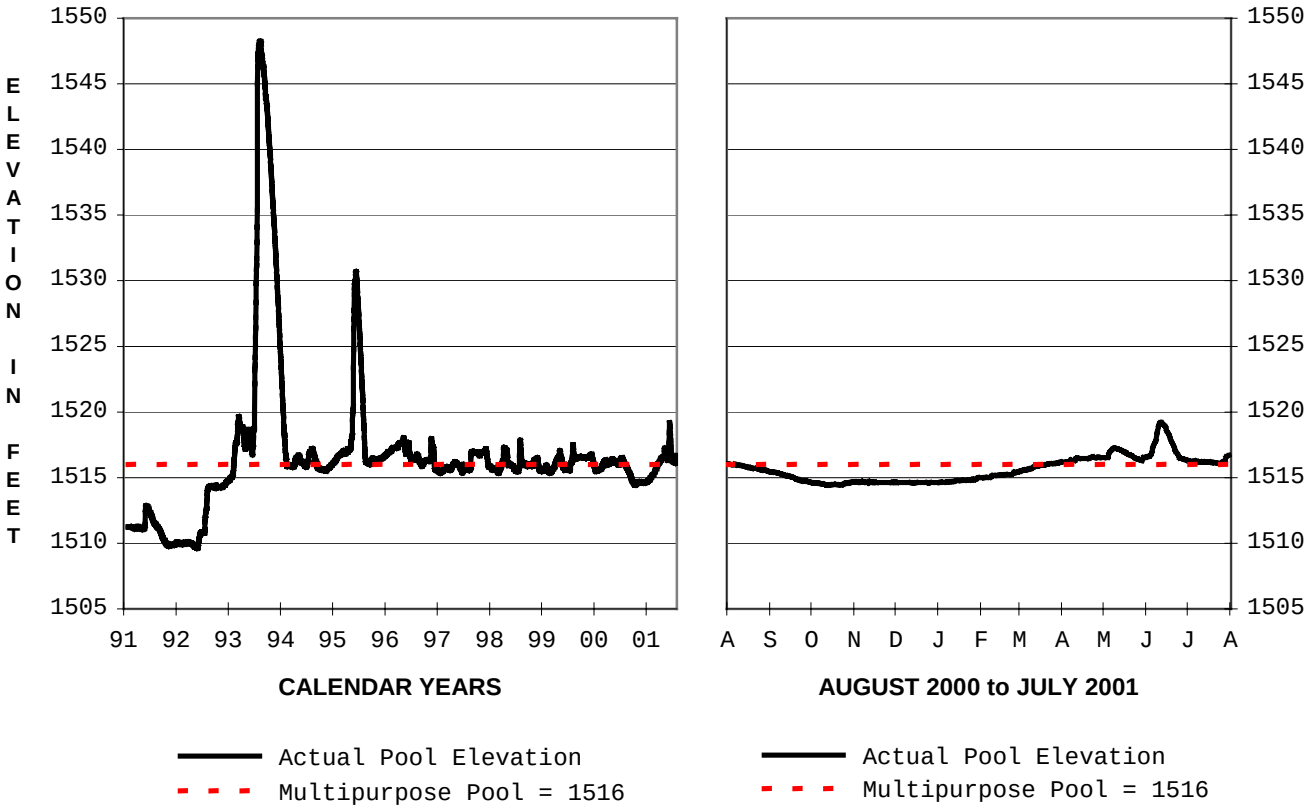



## TUTTLE CREEK LAKE ANNUAL INFLOW



# WILSON LAKE
# 2000 - 2001 REGULATION

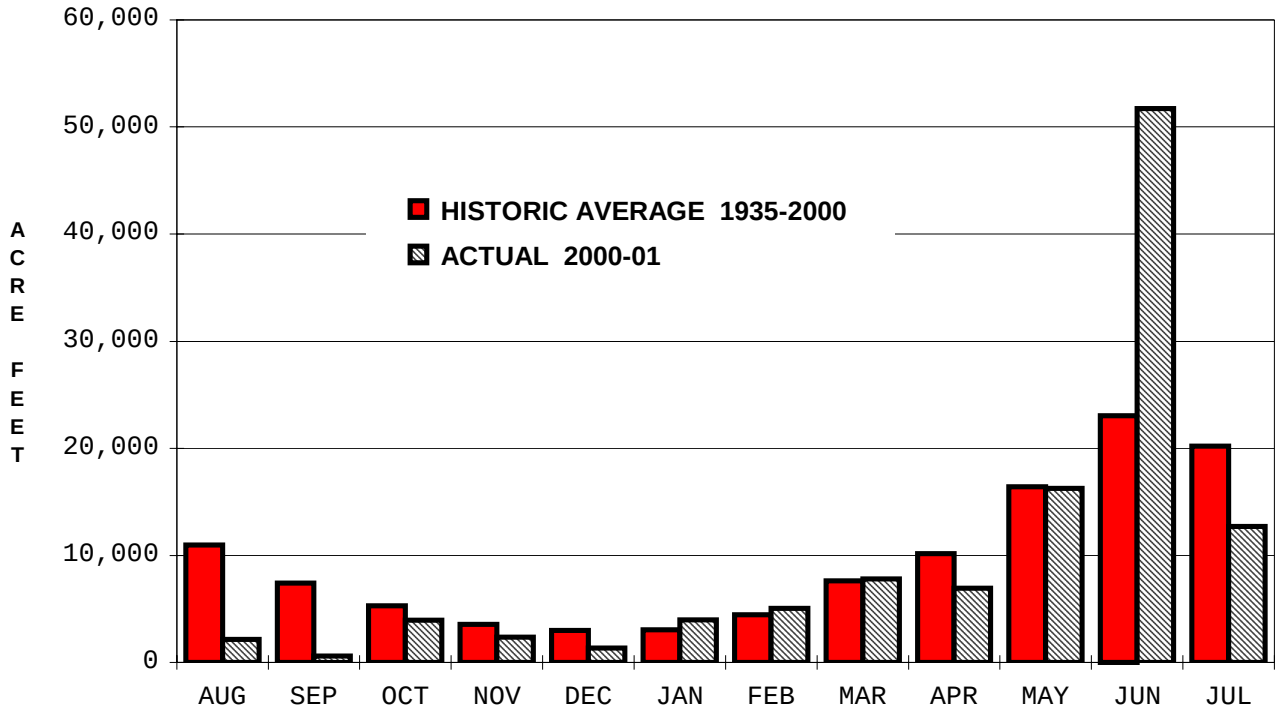
**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



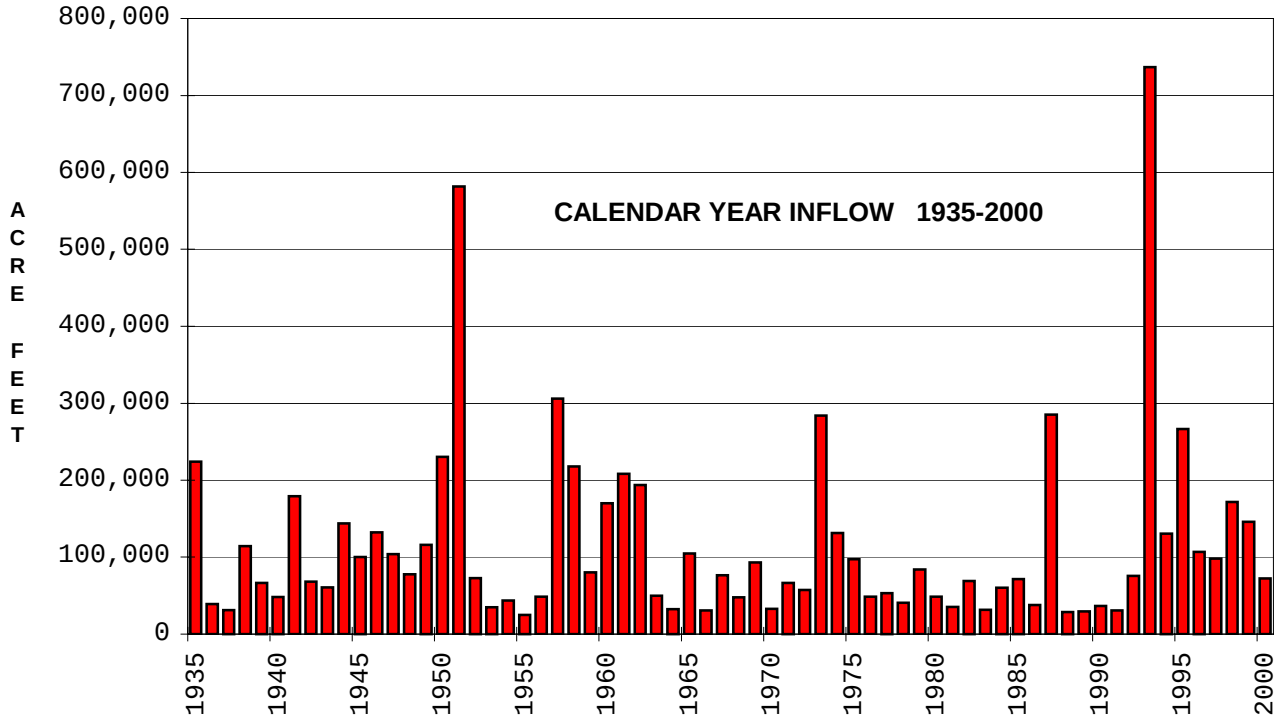

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1516.06<br>1 Aug 00** | **1516.69<br>31 Jul 01** | **1519.21<br>11 Jun 01** | **1514.43<br>12 Oct 00** | **1548.27<br>13 Aug 93** | **1509.62<br>27 May 92** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,600<br>9 Jun 01** | **114,825 (99%)<br>109,715 AF previous period** | **1,500<br>13-22 Jun 01** | **5 5 Oct to 5 Dec 00<br>7 Dec 00 to 13 Apr 01** |
| All outflows are to the river. Minimum required release of 5-15 cfs varies seasonally | | | |

## WILSON LAKE MONTHLY INFLOW




## WILSON LAKE ANNUAL INFLOW



**APPENDIX B**
**BUREAU OF RECLAMATION PROJECTS**

BONNY RESERVOIR

CEDAR BLUFF RESERVOIR

ENDERS RESERVOIR

HARRY STRUNK LAKE
(Medicine Creek Dam)

HUGH BUTLER LAKE
(Red Willow Dam)

KEITH SEBELIUS LAKE
(Norton Dam)

KIRWIN RESERVOIR

LOVEWELL RESERVOIR

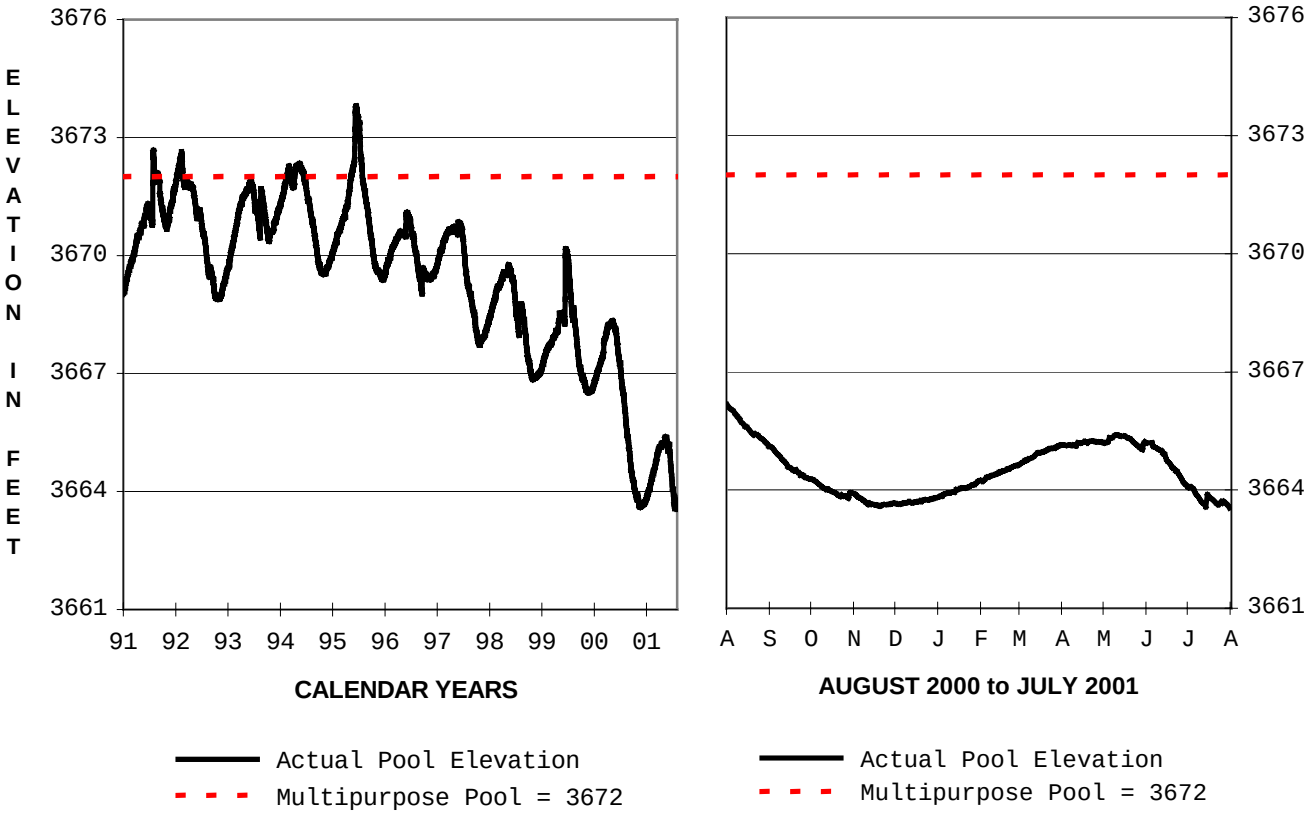
SWANSON LAKE
(Trenton Dam)

WACONDA LAKE
(Glen Elder Dam)

WEBSTER RESERVOIR

# BONNY RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



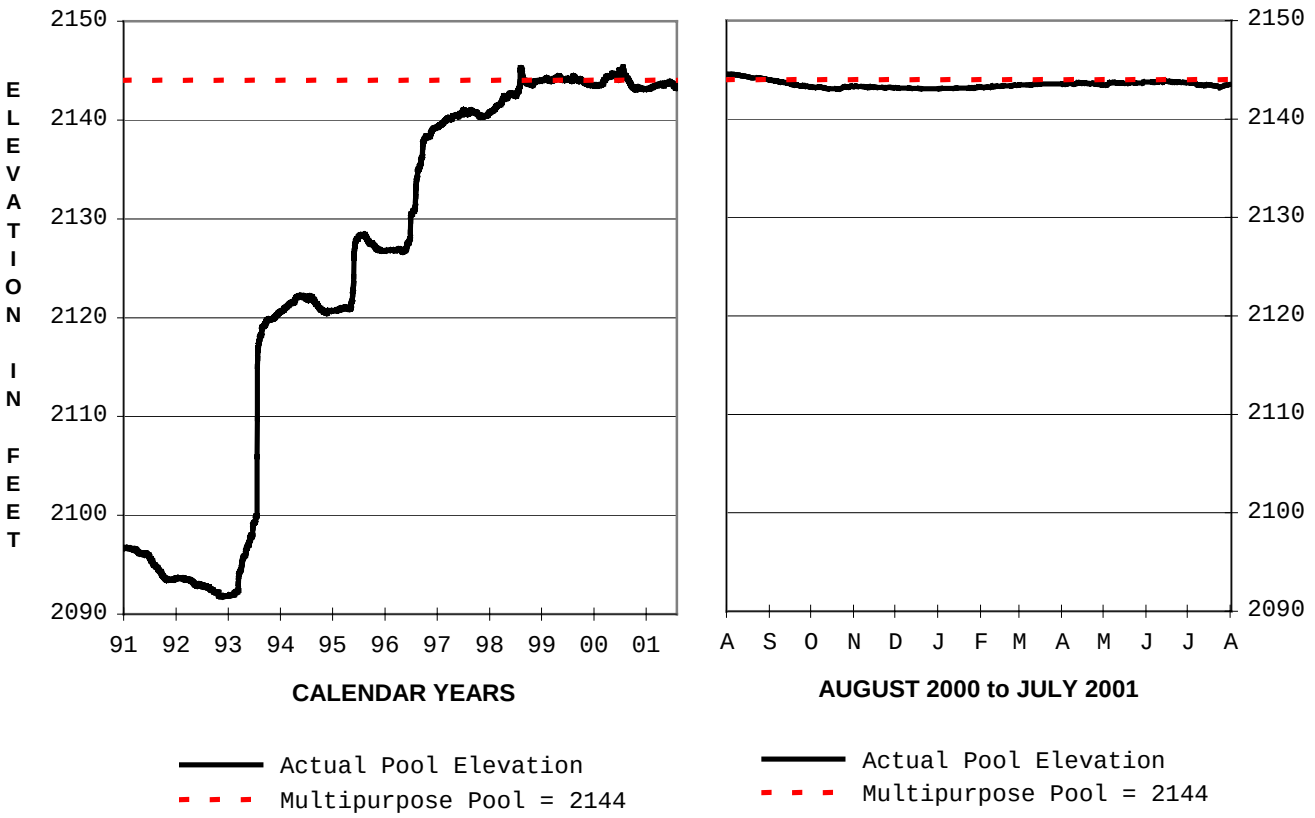

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **3666.18<br>1 Aug 00** | **3663.54<br>31 Jul 01** | **3666.18<br>1 Aug 00** | **3663.54<br>31 Jul 01** | **3678.10<br>17 May 57** | **3661.97<br>4 Jun 65** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **225<br>15 Jul 01** | **9,046 (54%)<br>11,476 AF previous period** | **7<br>10 Jun to 31 Jul 01** | **6<br>1 Aug 00 to 9 Jun 01** |

Max daily outflow is river release only. Max release with canal was 26 cfs on 16-18 Jun 01. Min release is 5 cfs.

# CEDAR BLUFF RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



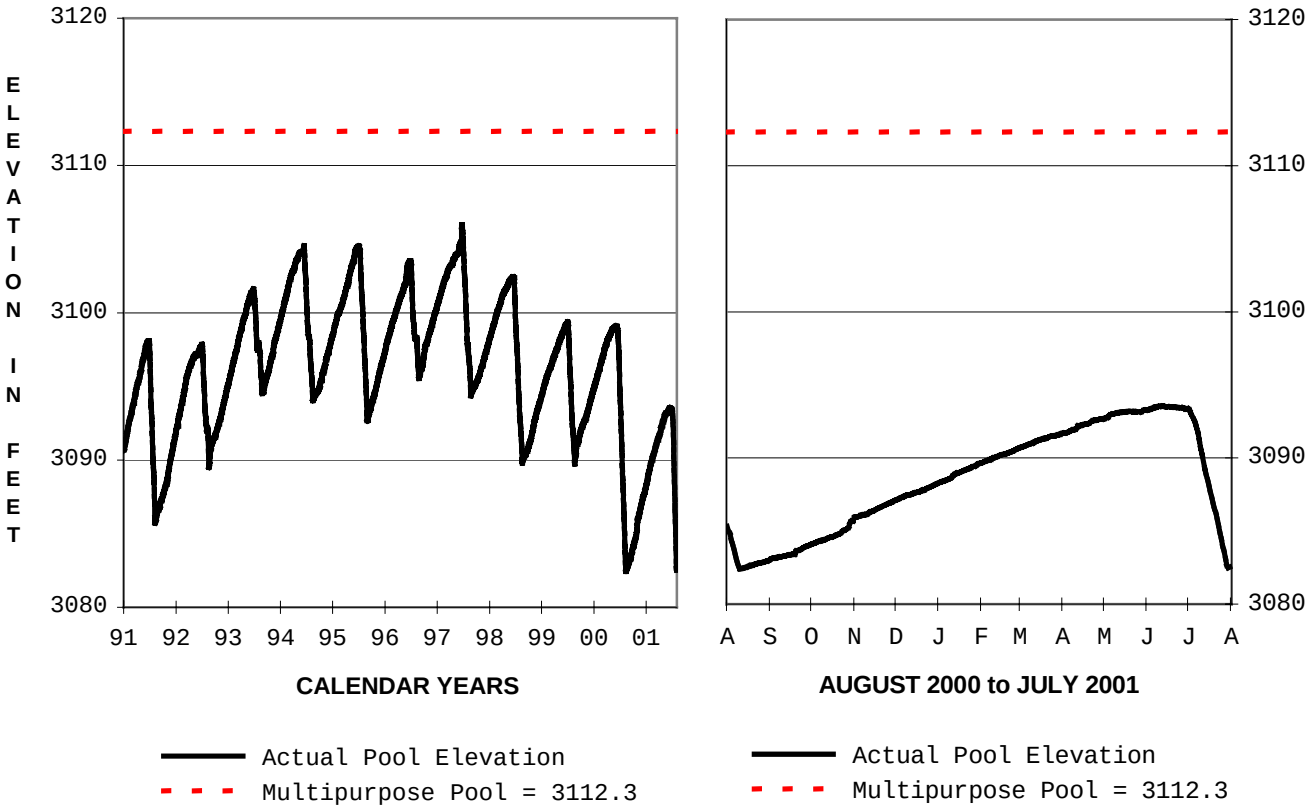

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2144.58<br>1 Aug 00** | **2143.51<br>31 Jul 01** | **2144.58<br>1 Aug 00** | **2143.06<br>20-21 Oct 00** | **2154.90, 2 Jul 51<br>4-5 Jul 57** | **2091.78<br>9-19 Nov 92** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **510<br>5 May 01** | **22,202 (162%)<br>46,639 AF previous period** | **300<br>1 Aug 00** | **0<br>Most of the year** |

Max daily outflow is river release only. No required min release. No canal releases. Minor releases to fish hatchery.

# ENDERS RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

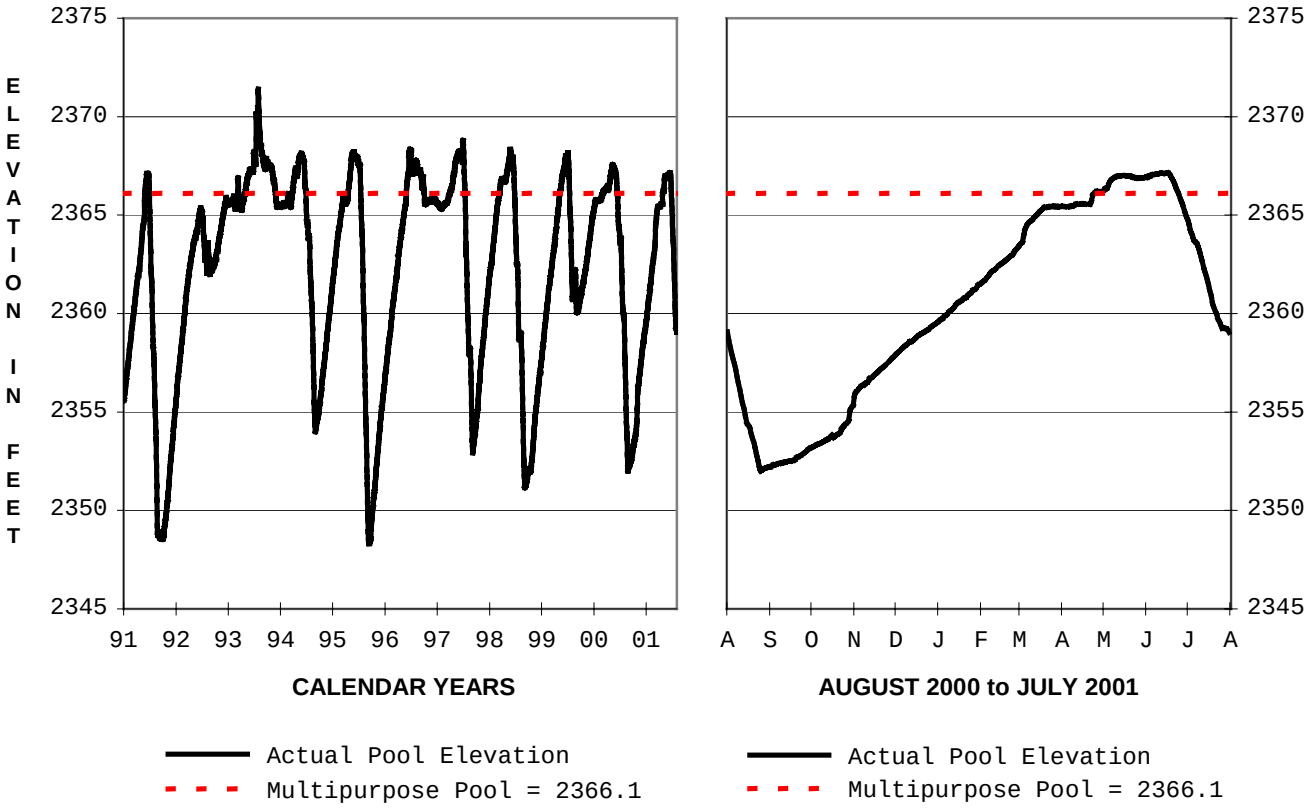



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **3085.32<br>1 Aug 00** | **3082.54<br>31 Jul 01** | **3093.55<br>13 Jun 01** | **3082.43<br>10-11 Aug 00** | **3118.20<br>25 Mar 60** | **3080.67<br>28 Aug 78** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **110<br>29 Oct 00** | **12,053 (56%)<br>14,971 AF previous period** | **247<br>10 Jul 01** | **1, most of the year when not irrigating** |
| Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release. | | | |

# HARRY STRUNK LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



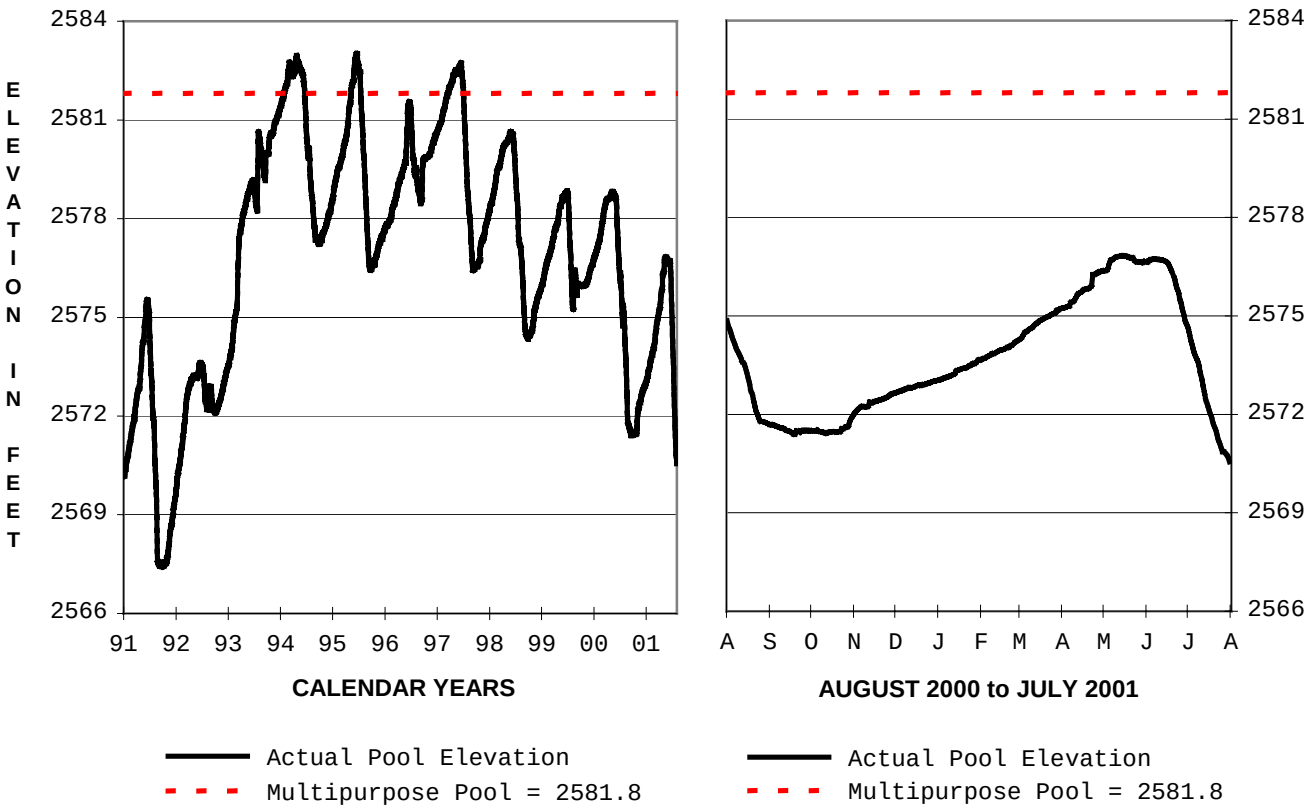

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2359.08<br>1 Aug 00** | **2359.04<br>31 Jul 01** | **2367.14<br>12, 17 Jun 01** | **2352.00<br>25 Aug 00** | **2374.10<br>23 Mar 60** | **2340.42<br>8 Sep 78** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **370<br>23 Apr 01** | **37,868 (96%)<br>37,882 AF previous period** | **291<br>1-2 Aug 00** | **1, most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release.

# HUGH BUTLER LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



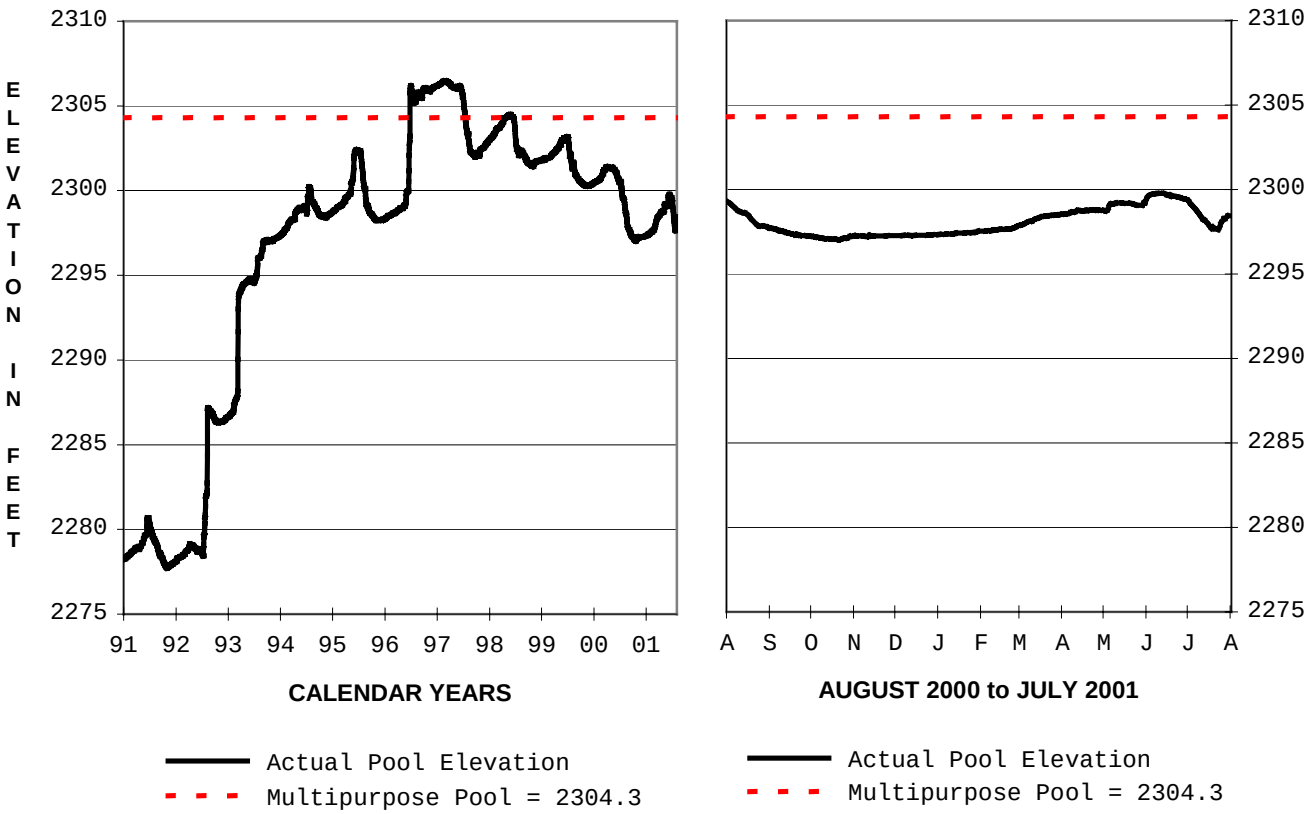

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2574.85<br>1 Aug 00** | **2570.55<br>31 Jul 01** | **2576.83<br>14-15 May 01** | **2570.55<br>31 Jul 01** | **2584.11<br>16 Jul 67** | **2565.28<br>9 Sep 78** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **250<br>23 Apr 01** | **13,349 (73%)<br>16,552 AF previous period** | **132<br>13 Jul 01** | **4, most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release.

# KEITH SEBELIUS LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD E XPANDED FOR READING EASE.**



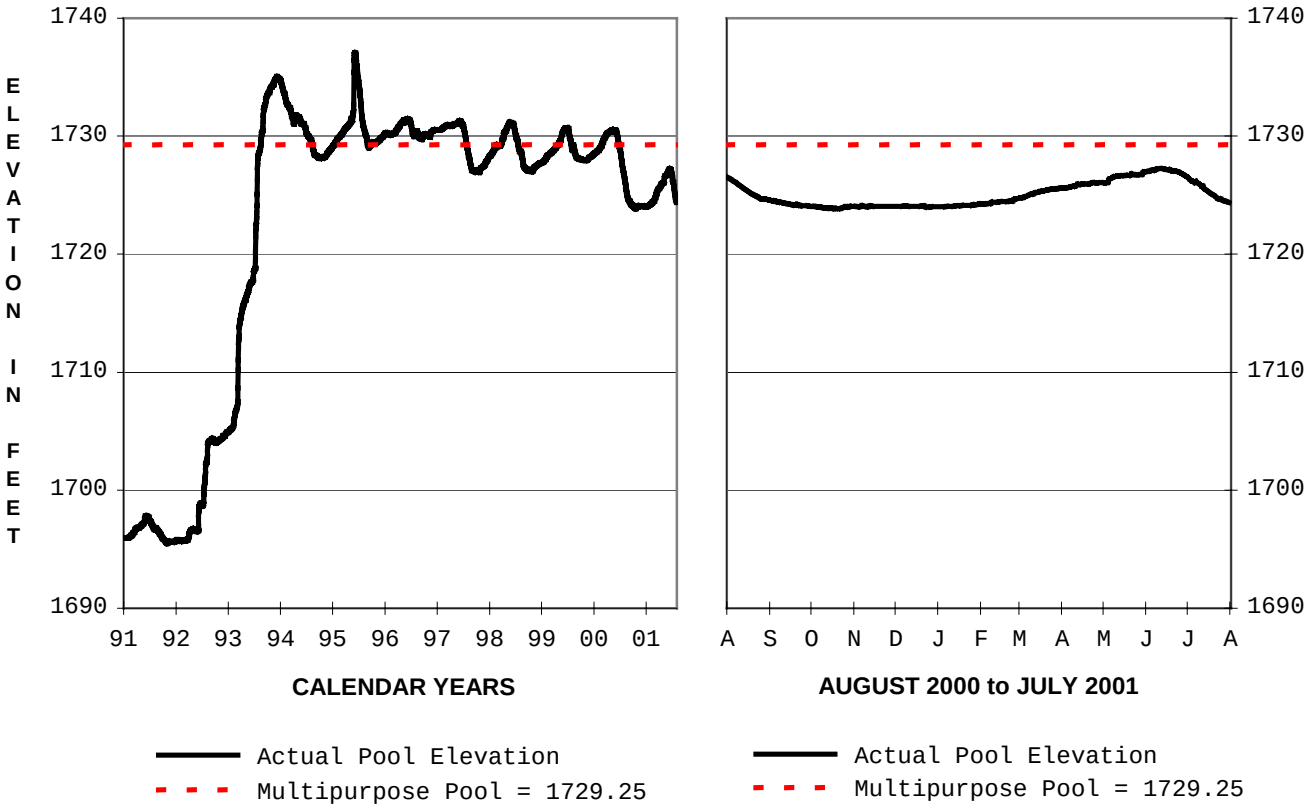

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2299.30<br>1 Aug 00** | **2298.45<br>31 Jul 01** | **2299.78<br>11 Jun 01** | **2297.03<br>21 Oct 00** | **2306.47<br>15 Feb to 4 Mar 97** | **2275.82<br>1 Feb 82** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **200<br>25 Jul 01** | **10,326 (150%)<br>8,874 AF previous period** | **80 10-12 Jul 01<br>16-19 Jul 01** | **1, most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. City release 0-2 cfs. No required min release.
Historic Minimum Pool Elevation of 2275.82 occurred on many days 28-29 Nov 81 and 20 Jan to 1 Feb 82.

# KIRWIN RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



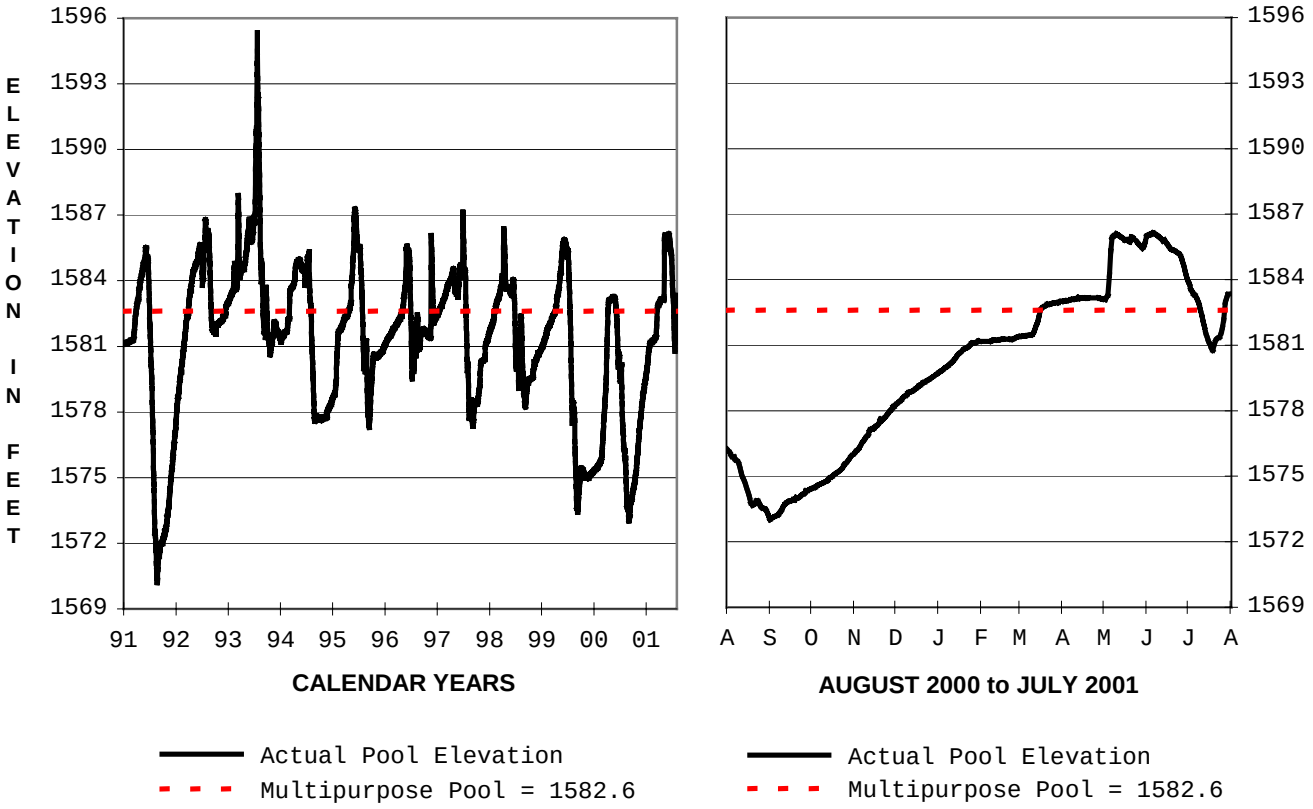

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1726.52<br>1 Aug 00** | **1724.37<br>31 Jul 01** | **1727.25<br>11-12 Jun 01** | **1723.86<br>20-21 Oct 00** | **1737.07<br>2 Jun 95** | **1695.45<br>11 Feb 81** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of norm) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **550<br>5 May 01** | **25,156 (119%)<br>32,692 AF previous period** | **0<br>Entire year** | **0, Entire year, no minimum required release** |

Maximum daily outflow is river release only. All releases to canal. Maximum canal release 192 cfs on 17 Jul 01.

# LOVEWELL RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



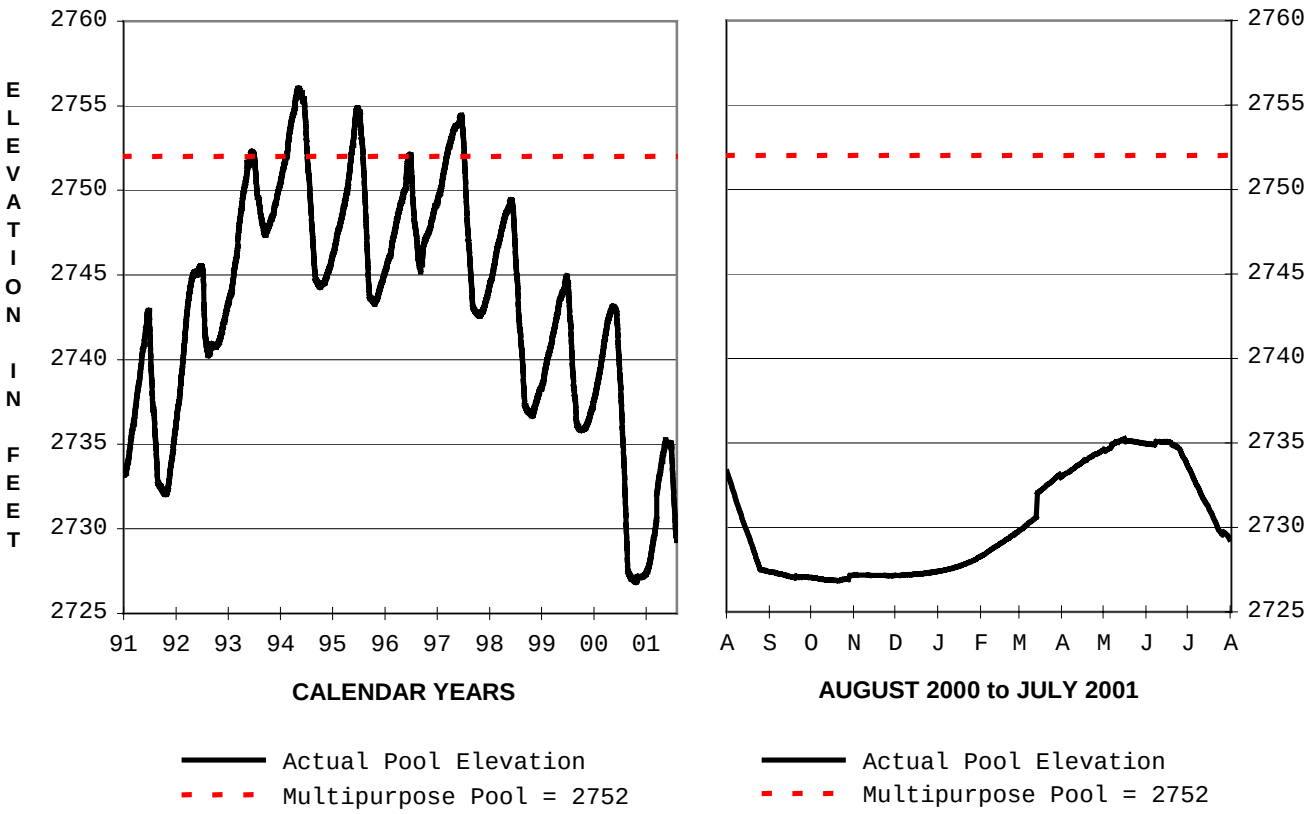

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1576.24<br>1 Aug 00** | **1583.34<br>31 Jul 01** | **1586.14<br>6 Jun 01** | **1573.02<br>1 Sep 00** | **1595.34<br>22 Jul 93** | **1570.20<br>22 Aug 91** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **1,820<br>6 May 01** | **35,200 (122%)<br>9,200 AF previous period** | **100<br>10 May to 18 Jun 01** | **0<br>Most of the year** |

Maximum daily outflow is river release only. Maximum canal release 534 cfs on 12 Jul 01. No required min release.

# SWANSON LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



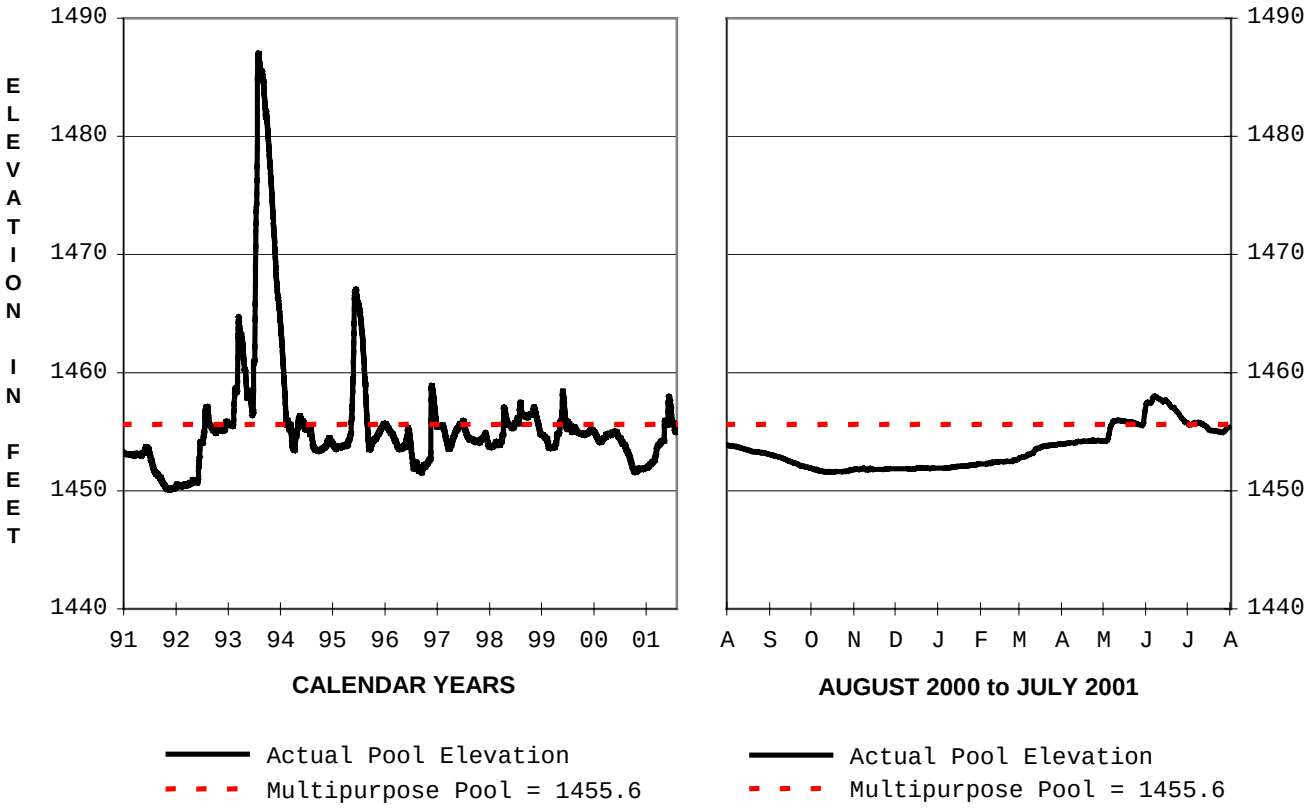

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2733.29<br>1 Aug 00** | **2729.30<br>31 Jul 01** | **2735.25<br>16 May 01** | **2726.85<br>21 Oct 00** | **2757.40<br>3-4 Aug 62** | **2725.90<br>16-18 Nov 76** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **235<br>27 Jul 01** | **24,910 (40%)<br>38,712 AF previous period** | **125<br>4-7 Aug, 9-10 Aug 00** | **1, most of the year when not irrigating** |

Max daily outflow is river release only. Max release with canal was 355 cfs on 4-7 Aug 00. No required min release.

# WACONDA LAKE
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



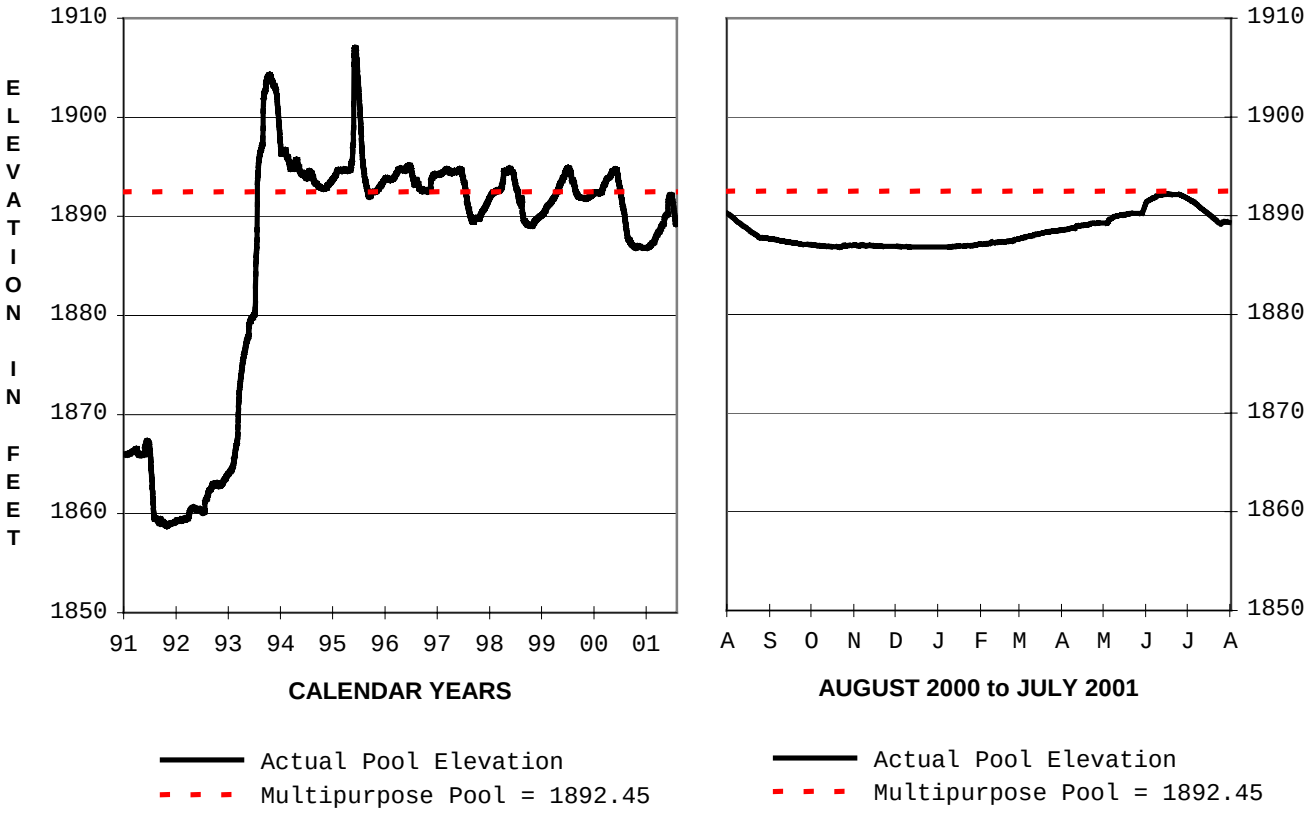

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1453.86<br>1 Aug 00** | **1455.35<br>31 Jul 01** | **1457.98<br>7 Jun 01** | **1451.59<br>11 Oct 00** | **1487.02<br>29 Jul 93** | **1448.90<br>6-7 Dec 84** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **7,000<br>30 May 01** | **150,207 (110%)<br>114,302 AF previous period** | **1,000 10-19 Jun 01<br>23-28 Jun 01** | **20 15-19 Oct 00<br>27 Oct 00 to 8 May 01** |

The max daily outflow is river release only. Also have municipal releases from pool. Normal min release is 24 cfs.

# WEBSTER RESERVOIR
# 2000 - 2001 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**




| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1890.23<br>1 Aug 00** | **1889.31<br>31 Jul 01** | **1892.16<br>18 Jun 01** | **1886.80<br>2 Jan 01** | **1907.04<br>5 Jun 95** | **1857.35<br>22-29 Oct 71** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **810<br>31 May 01** | **25,582 (150%)<br>28,996 AF previous period** | **184<br>24 Jul 01** | **0<br>26 Aug 00 to 25 Jun 01** |

All releases to river. Max daily outflow occurred as part of normal irrigation releases. No required minimum release.